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PHYSICS ABSTRACTS

SECTION A

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SCIENCE ABSTRACTS

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SECTION B, ELECTRICAL ENGINEERING

Edited and Issued Monthly by

THE INSTITUTION OF ELECTRICAL ENGINEERS

In Association with

THE PHYSICAL SOCIETY

THE AMERICAN PHYSICAL SOCIETY

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INSTITUTE OF ELECTRICAL ENGINEERS

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VOLUME 53 **MARCH 1950** NUMBER 627

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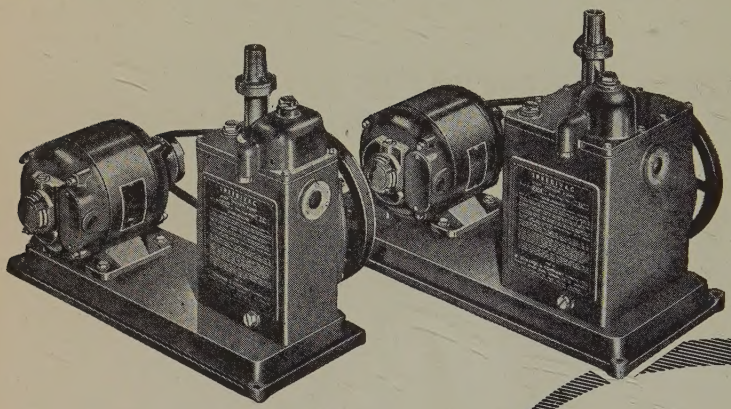

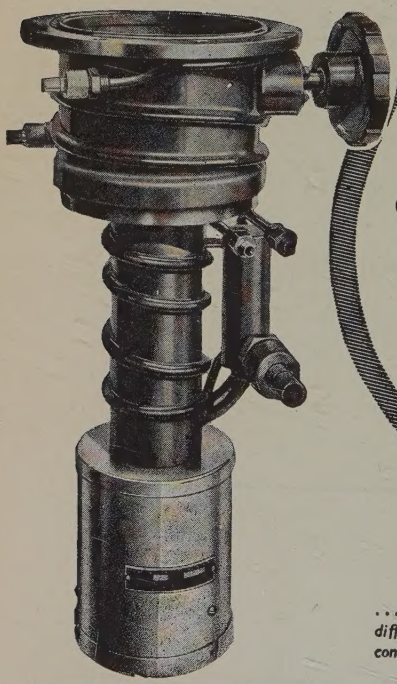

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Mechanical engineering
Illumination
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The following list supplements that published with the January Number of Vol. 53 (1950). Journa marked * are not received regularly though abstracts of articles from them are occasionally published. Th addresses given are believed to be correct, but no responsibility can be accepted for errors.

**Ann. Comput. Lab. Harv. Univ.*	*Annals of the Computational Laboratory, Harvard University* [Abstracted by *Index Aeronauticus.*]
Ann. Inst. Poincaré	*Annales de l'Institut Henri Poincaré.* 11 Rue Pierre-Curie, Paris (5e
Brennstoff-Wärme-Kraft [*BWK*]	*BWK. Brennstoff-Wärme-Kraft.* Zeitschrift für Energiewirtschaf Deutscher Ingenieur-Verlag, Prinz-Georg-Strasse 77, Düsseldorf.
**C.R. Soc. Sci. Lett. Varsovie, Cl. III Sci. Math. Phys.*	*Comptes Rendus de la Société des Sciences et des Lettres de Varsovie Classe III des Sciences Mathématiques et Physiques.* Warsaw.
Cath. Press	*Cathode Press.* Machlett Laboratories, Springdale, Connecticut.
Elekt. Bahnen	*Elektrische Bahnen.* R. Oldenbourg, Schliessfach 31, Munich 1.
Elektrizitätsverwertung	*Elektrizitätsverwertung—L'Electrique—Electrical Service.* Elektro wirtschaft, Bahnhofplatz 9, Zürich 23.
Elin-Z.	*Elin-Zeitschrift.* Volksgartenstrasse 1–5, Vienna 1/1.
Guide Russ. Sci. Period. Lit.	*Guide to Russian Scientific Periodical Literature.* Information an Publications Division, Brookhaven National Laboratory, Upton Long Island, New York.
L.S.E. Engng Bull.	*L.S.E. Engineering Bulletin.* Laurence, Scott and Electromotors Ltd. Manfield House, Southampton Street, Strand, London, W.C.2.
Mém. Artill. Franç.	*Mémorial de l'Artilleria Française.* [Abstracted by *Index Aero nauticus.*]
Sci. Pap. Inst. Phys. Chem. Res., Tokyo	*Scientific Papers of the Institute of Physical and Chemical Research* The Scientific Research Institute, Ltd., Komagome, Bunkyo-Ku Tokyo. [Now *Journal of the Scientific Research Institute.*]

ABSTRACT JOURNALS

Brookhaven Guide to Russian Literature	*Guide to Russian Scientific Periodical Literature.* Information an Publications Division, Brookhaven National Laboratory, Upton Long Island, New York.

ORIGINAL ARTICLES

It is regretted that the articles from which abstracts are made cannot be sent out on loan. Application should be made to appropriate lending libraries or to the publisher of the Journal concerned; publishers' addresses, where known, are given in the "List of Journals" published with the January Number of Vol. 53 (1950), or in the supplementary lists published subsequently.

ERRATA

Index (1948): **Hall effect.** First entry, *for* 2419 *read* 2499.

Abstr. 4108 (1949): line 2, *insert* ROBERTS, A. as joint author.

Abstr. 4374 (1949): line 3, *for* Breids, I. I. *read* Breido, I. I.

Abstr. 5525 (1949): line 3, *for* **55** *read* **65.**

Abstr. 6257 (1949): line 4, *for* "Sb_2O_3" *read* "Sb_2S_3".

line 6, *delete* "pulsed".

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MATHEMATICS 51

517.512.2 : 621.3.018.3

1378. A simple method of calculating the harmonics of a periodic function. V. SVOBODA. *Elektrotech. Obz.*, **38**, 12–17 (*Jan.* 15, 1949) *In Czech.*

The principles of harmonic analysis by the method of discontinuities are explained, the method then being applied to curves of technical interest, whose characteristics permit of simplifying the general expressions obtained. The examples refer to 3-ph. rectification, including transient conditions, voltage to earth in different points of the star-connected transformer groups in the circuit of a 24-ph. h.v. rectifier, the chief problem being the determination of the resulting harmonics from the known harmonics of the partial functions. B. F. KRAUS (R)

517.93 : 534.01 : 621.3.015.4

1379. On the phenomenon of subresonance according to the equation of van der Pol. A. ROSENBLATT. *Bol. Fac. Ing. Montevideo*, **3**, 345–54 (*June*, 1949) *In Spanish.*

The equation $x'' + \omega_n^2 x + \mu x'(A + Cx^2) = a \exp(i\omega t) + b \exp(-i\omega t)$, is solved as a power series in μ, and conditions are found, in order that solutions exist representing vibrations with proper frequency ω_n. L. S. GODDARD

517.942 : 537.222

1380. The application of non-integral Legendre functions to potential problems. R. N. HALL. *J. Appl. Phys.*, **20**, 925–31 (*Oct.*, 1949).

There are a number of important potential problems having axial symmetry and involving a conical boundary whose solutions require the use of zero-order Legendre functions of real but non-integral degree. The numerical evaluation of such problems is relatively simple once the zeros of these functions have been determined and when certain integrals have been evaluated. Tables and curves giving this information, together with a number of approximate expressions for these quantities, are presented. A number of potential distributions involving conducting cones, spheres and rings is worked out to illustrate the application of these functions. A.

518.5 : 532.5 : 536.24

1381. Application of electric-analog computers to heat-transfer and fluid-flow problems. G. D. MCCANN, JR. AND C. H. WILTS. *J. Appl. Mech.*, **16**, 247–58 (*Sept.*, 1949).

518.5 : 621.318.572

1382. The EDSAC—an electronic calculating machine. M. V. WILKES and W. RENWICK. *J. Sci. Instrum. Phys. Ind.*, **26**, 385–91 (*Dec.*, 1949).

The EDSAC is a large-scale machine in which ultrasonic delay units are used for storage of orders and numbers. It is serial in operation and works in the scale-of-2. Punched tape is used for input and a teleprinter for output. The paper describes the functions of the various units of which the machine is composed, and explains with block diagrams the manner in which orders are taken one by one from the store and executed. A.

519.2

1383. Formulas for the percentage points of the distribution of the arithmetic mean in random samples from certain symmetrical universes. U. CHAND. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 79–80 (*July*, 1949).

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.11

1384. Harmonic relationships between revolutional periods in the system sun–earth–moon. R. SCHUMANN. *S.B. Akad. Wiss. Wien*, **148** (*Nos* 5–6) 253–61 (1939) *In German.*

Continuation of the author's earlier work [*S.B. Akad. Wiss. Wien*, **145** (*No.* 5), I and II (1936), and *Astr. Nachr.*, **261** (*No.* 6247) (1936)], which introduces resonance equations to establish numerical correlations between the various periodicities. A. BEER

522.14 : 551.59

1385. The influence of the earth's atmosphere on astronomical observations. H. SIEDENTOPF. *Naturwissenschaften*, **35** (*No.* 10) 289–98 (1948) *In German.*

Critical discussion of the important problem how far atmospheric observing conditions will permit a further increase in size of the present type of astronomical telescopes. The limitations are given by: (1) the effects of absorption and diffraction on the stellar radiation, (2) the direct radiation of the night sky, and (3) the turbulence of the atmosphere, which continuously causes variations in direction and intensity. As possibilities to overcome these difficulties are considered: Observations in great heights (mountain stations, aircraft, rockets); monochromatic observations (Lyot–filter, etc.); short-wave radio work (1 cm–20 m); and observations of the secondary effects caused in the atmosphere by incoming corpuscular- and wave-radiations, which do not penetrate down to the earth's surface. A. BEER

522.21 : 535.317.5

1386. On the optics of the Schmidt camera. E. H. LINFOOT. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 3) 279–97 (1949).

A general aberration theory of the standard Schmidt camera is developed and used to suggest improvements in the optical performance. The fifth-order aberration function of the system is derived, axial colour correction is discussed, and proofs are given of Baker's formulae [Abstr. 2046 (1940)] for the aspheric plate profile of a system with minimum axial colour spread. A modified system in which the monochromatic aberrations are balanced over a finite field gives smaller images which are nearly uniform over the whole field without seriously increasing the amount of figuring needed. A. HUNTER

522.6 : 621.396.9 : 621.396.11

1387. Radio astronomy. J. S. HEY. *Nature, Lond.*, **164,** 815–17 (*Nov.* 12, 1949).

This summary of the proceedings of Section A of the B.A. meeting at Newcastle-upon-Tyne refers to the following papers: (*a*) J. S. Hey, The characteristics of the radio emission from sunspots and solar flares, the correlation of the received emissions with visual observations and solar ionospheric effects, and the method of examining the spectrum of the emission; (*b*) F. G. Smith, The characteristics of galactic radio noise, the interference methods used to obtain high resolution, and the possible nature of the sources of the emissions; (*c*) A. C. B. Lovell, The development of techniques for the examination of the phenomenon of ionization of the upper atmosphere by meteors, and the determination of meteor velocities and the structure of meteor streams by radar methods.

M. W. OVENDEN

522.6 : 621.396.9 : 621.396.11

1388. Radio astronomy. J. S. HEY. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 2) 179–214 (1949).

A progress report outlining the fundamentals of radio transmission and reception in the m and cm bands, and discussing technique and results in the radar observation of meteor trails and of the moon, and in the investigation of galactic and solar radio noise. A full bibliography is appended. A. HUNTER

523.11 : 539.17

1389. The genesis of the chemical elements. D. TER HAAR. *Ned. T. Natuurkde*, **15,** 85–95 (*April*, 1949) *In Dutch.*

A critical survey of work on the subject during the last decade. The main aspects discussed, starting with Klein, Beskow and Treffenberg's original theory [Abstr. 414 (1947)] are: excited condition of the nuclei; electrostatic effects (important at the high densities considered); effects of gravitation. Secondary problems are the transition from extreme temps. and densities to normal ones without upsetting the state of equilibrium; transition from possibly radio-active nuclei to the stable ones; the region where these hypothetical processes occur; relation between these processes and cosmogony (star formation proper). The most recent cosmogonical theory, that of Gamow and Alpher, explaining the present concentrations of elements on a synthetic process of an almost spontaneous character at the beginning of time according to the sequence of "creation": neutrons–protons–deuterons, leads to a good agreement between calculated and existing concentrations of elements; yet the other theories, i.e. those more concerned with the role of the stars, agree among themselves on the fact that the present concentration can be fully explained by later eruptions of *O*, *B* and *A* stars. The conclusion drawn by the author is that the present state is more or less stationary. B. F. KRAUS

523.112

1390. On the cosmological problem. F. HOYLE. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 3) 365–71 (1949).

Mathematical criticisms [Abstr. 3674 (1949)] of the author's model [Abstr. 3754 (1949)] for the expanding universe are shown not to apply to a general theory free of the approximation which smoothes out the extragalactic nebulae into a uniform background. Aesthetic objections rejecting relativity in favour of Mach's postulate are themselves shown to lead to difficulties. A. HUNTER

523.3

1391. Microwave thermal radiation from the moon. J. H. PIDDINGTON AND H. C. MINNETT. *Aust. J. Sci. Res. A.*, **2,** 63–77 (*March*, 1949).

The radiation from the whole lunar disc has been measured during several phase cycles in a 15 Mc/s band centred at 24 000 Mc/s. Curves of deduced temp. against phase angle have been drawn, one corresponding to average temp. over the disc, the other to the temp. on the equator. They are approximately sinusoidal, with amp. $\pm 40{\cdot}3°$K and $\pm 52{\cdot}0°$K respectively, and with a lag of about $\pi/4$ on the lunar phase angle in each case. These results conflict both in amp. and phase with previous i.r. measurements. An explanation is given in terms of radiation from subsurface layers of the moon's crust, which are partially transparent to cm waves. The theory is quantitatively developed and it is found that the results are consistent with the existence of a thin layer of dust covering a solid surface. Estimates are made of the temps. of the disc of the new moon (156°K) and of the deep interior (241°K). A.

523.4

1392. The second satellite of Neptune. G. P. KUIPER. *Publ. Astr. Soc. Pacif.*, **61,** 175–6 (*Aug.* 1949).

Details of observations are given and a provisional orbit deduced. M. W. OVENDEN

523.57 : 523.8

Sodium D in the spectrum of meteors. *See Abstr.* 1430

523.7

1393. On the origin of the chromospheric turbulence and of the ultraviolet excess of the solar radiation. L. BIERMANN. *Z. Astrophys.*, **25** (*Nos* 1–2) 161–77 (1948) *In German.*

The hypothesis of pressures waves is put forward and worked out in its mathematical details, which originate through the action of the solar granulation elements (ascending from the H convection zone) against the border region of the stable photospheric layers. Analogies with meteorological and hydrodynamical results are mentioned. A. BEER

523.72

1394. Solar radiation at 1 200 Mc/s, 600 Mc/s and 200 Mc/s. F. J. LEHANY AND D. E. YABSLEY. *Aust. J. Sci. Res. A.*, **2,** 48–62 (*March*, 1949).

Daily observations of solar radiation at these frequencies taken between Aug. 18 and Nov. 30, 1947, are described. The characteristics of the radiation at 200 Mc/s were in general agreement with those observed by earlier workers. At 600 Mc/s and 1 200 Mc/s, the received intensity was normally steady on any one day but underwent long-period variations over a range of about 2 : 1. The radiation received when the sun was almost free of sunspots corresponded to an effective black-body temp. of 0·5 million °K at 600 Mc/s and 0·1 million °K at 1 200 Mc/s. As sunspots appeared, the temp. rose and showed marked correlation with sunspot area. It is considered that radiation at these frequencies is

entirely thermal in origin and that the long-period variations are at least partly due to the influence of the magnetic field of sunspots on the mechanism of thermal emission from a magneto-ionic medium. On a few occasions, isolated disturbances were observed on 600 Mc/s and 1 200 Mc/s, some of which were associated with chromospheric flares and radio fade-outs. The difficulties arising in the calibration of the apparatus and the steps taken to overcome them are discussed in detail. A.

523.72

1395. Detection of solar radio radiation reflected by the moon. J.-L. STEINBERG AND S. ZISLER. *C.R. Acad. Sci., Paris*, **229**, 811–12 (*Oct.* 24, 1949) *In French.*

A receiver working at 158 Mc/s with a modulating frequency of 530 c/s and having a min. observable signal strength of $2{\cdot}5\times10^{-23}$ W/cycle/m^2, detected a signal from the moon of 3×10^{-23} W/cycle/m^2. Comparison with solar radiation gives a lunar reflection coeff. of about 10%. M. W. OVENDEN

523.72

1396. Observations of solar radiation on a wavelength of 55 centimetres. M. LAFFINEUR AND J. HOUTGAST. *Ann. Astrophys.*, **12**, 137–47 (*April–June*, 1949) *In French.*

The construction, calibration and characteristics of an altazimuth 7·5 m parabolic receiver, with secondary reflector and visual recording on a voltmeter (time constant 300 msec) are described. Observations of the mean intensity of solar radiation leads to an effective solar temp. of $2{\cdot}4\times10^5$ °K; the higher values found by other workers on metre wavelengths are attributed to the variation of optical depth of the corona with wavelength. Observed "bursts" of radiation are correlated with solar and other associated terrestrial phenomena. An observed fluctuation between 1 and 1·4× normal intensity, with a frequency of 20/sec resembles the effect of interference of two coherent groups of waves with variable phase difference; this fluctuation is believed to be of solar origin. M. W. OVENDEN

523.74 : 537.591

On the origin of the solar component of the cosmic radiation. *See Abstr.* 1826

523.741

1397. The refractive index of the solar atmosphere, and the trajectory of light rays at the extreme edge of the solar disc. P. PROISY. *Ann. Astrophys.*, **12** (*No.* 2) 123–36 (*April–June*, 1949) *In French.*

Calculation of the refractive index of the solar atmosphere (at $\lambda = 0{\cdot}5\mu$), based on recent data regarding the constitution of stellar atmospheres, enables the trajectories of rays emanating from the extreme border of the solar disc to be computed with a satisfactory degree of precision. It is shown that, within this narrow region, the variation in optical depth is of far more importance than the image displacement which results from pure refraction. D. R. BARBER

523.742

1398. Influence of the refraction of light rays in the solar atmosphere on the radiation near to the sun's limb. Intensity variations at the limb. P. PROISY. *C.R. Acad. Sci., Paris*, **228**, 1369–71 (*April* 25, 1949) *In French.*

It is demonstrated that the intensity passes through a maximum between a central distance of 0·9998 of the sun's radius and the extreme limb. A. BEER

523.742

1399. Influence of the curvature of the solar atmosphere on the intensity of monochromatic radiation near to the sun's limb. P. PROISY. *C.R. Acad. Sci., Paris*, **228**, 1102–4 (*March* 28, 1949) *In French.*

Expressions are derived giving the intensity of radiation as functions of the angle under which the ray traverses the various layers of different optical depth of the stellar atmosphere, of the ratio of the emission and absorption coeffs. at each point of the ray, and of the intensity at the centre of the disc. The relative influence of these various factors is discussed, and numerical values for $\lambda = 5\,000$ Å are tabulated. A. BEER

523.746 : 537.591

1400. Sunspots and cosmic ray intensity. K. C. CHADHA. Letter in *Curr. Sci.*, **18**, 202–3 (*June*, 1949).

523.747

1401. The frequency and positions of flares within three active sunspot areas. H. W. DODSON AND E. R. HEDEMAN. *Astrophys. J.*, **110**, 242–9 (*Sept.*, 1949).

Continuous spectroheliographic records of 3 active sunspot groups secured during 105 hr of observation include 83 flares for which the intensity was at least 4 times the intensity of the undisturbed disc of the spectroheliograms. Composite maps of these flares indicate that they occurred repeatedly in the same location and with a certain continuity or chainlike nature in position. Although they appeared most often in the region between spots, or close to and over the penumbrae of spots, upon occasion, they seemed to occur exactly over the umbrae of the spots. Many flares appeared to follow, in part, channels already established by dark filaments (prominences seen in projection on the disc); the filaments persisted even though they were adjacent to, or apparently over, the bright flares. Spectroheliograms of one spot group carry the record of a hitherto unreported, postflare phenomenon. Flare 1 of July 29, 1947, and flares 2, 3 and 4 of July 31, 1947, occurred in the same position and were followed by the ejection of a long bright streamer. In each case the streamer was at first brighter than the undisturbed disc of the H spectroheliogram and then became dark or bordered by a region of dark absorption. A.

523.75

1402. Observations of prominences and the solar chromosphere carried out in 1948. G. ABETTI. *Mem. Soc. Astr. Ital.*, **20** (*No.* 3) 177–81 (1949). Also *Ossvz. Mem. Oss. Astr. Arcetri*, **65**, 101–5 (1949) *In Italian.*

523.75

1403. The heating of the solar corona. E. SCHATZMAN. *C.R. Acad. Sci., Paris*, **228**, 738–9 (*Feb.* 28, 1949) *In French.*

Numerical estimates are obtained on the basis of Schwarzschild's hypothesis [Abstr. 1749 (1948)] which considers compression waves caused by the movements in the solar granulation. For the duration of the resulting shock waves a value of 15 sec is given; for their mean velocity in the chromosphere

4 km/sec; and for the mechanical energy transported into the chromosphere $10^{27 \cdot 5}$ ergs. Within a suggested model of the chromosphere and inner corona the max. temp. is found at 0·056 of a solar radius above the disc. A. BEER

523.75

1404. Variations with depth of the abundance of the constituents of the solar atmosphere, and of its refractive index. P. PROISY. *C.R. Acad. Sci., Paris*, **228**, 739–41 (*Feb.* 28, 1949) *In French.*

The calculations are applied to Barbier's and de Jager's model of the sun's atmosphere [*Ann. Astrophys.*, **9**, 173 (1946) and *Proc. K. Ned. Akad. Wet.*, **51**, 731 (1948)]. They are tabulated for optical depths ranging from 0·01 to 9·0, giving the corresponding depths in km (0–310), the temps. (4 950°–8 675°K), the number of atoms and free electrons ($N_H + N_{He}$: $1 \cdot 99 \times 10^{16}$–$18 \cdot 09 \times 10^{16}$; N_{H^-} : $7 \cdot 58 \times 10^7$ to more than $7 \cdot 91 \times 10^{10}$; N_e : $2 \cdot 73 \times 10^{12}$–$2 \cdot 15 \times 10^{15}$), and the refractive index for 5 000 Å ($1 \cdot 05 \times 10^{-7}$–$7 \cdot 12 \times 10^{-7}$). A. BEER

523.75

1405. A note on heat transfer in the upper chromosphere and corona. R. G. GIOVANELLI. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 3) 372–8 (1949).

Calculations of the thermal conductivity of a highly ionized medium show that conduction is adequate to transfer heat through the corona to the chromosphere, but below that the transfer must be mainly by convection. These conclusions differ from those of Bondi, Hoyle and Lyttleton [Abstr. 3087 (1948)] whose convective model of the corona breaks down in the presence of the sun's general magnetic field.

A. HUNTER

523.75

1406. On the correlation between the chromosphere- and corona-spectra of the sun and the excitation in the chromosphere. K. WURM. *Z. Astrophys.*, **25** (*Nos* 1–2) 109–34 (1948) *In German.*

It is shown that the degree of the observed deviations from temp. equilibrium requires a strict distinction between ionization-, excitation- and electron temps., which do not show any close connection. The ionization increases continuously outward from the basis of the chromosphere. The energy of the over-excitation in the chromosphere appears as u.v. radiation, or as stored ionization energy. Sources of kinetic energy of the gas particles, like turbulence and corpuscular streams, can be excluded as causes of the over-excitation. The same applies to the prominences. The electron temp. does not show any noticeable increase throughout the whole of the chromosphere. The absence of forbidden lines puts the electron temp. below $10^{4\circ}$; the increase to the $10^{6\circ}$ of the corona must take place quite suddenly at the border of both layers. A tentative explanation of the small electron temp. in chromosphere and prominences is suggested by assuming the existence of a mixture with atoms and ions of small energies, which are taken to be absent in the corona. A. BEER

523.75

1407. Hall currents and the ejection of prominences by sunspots. R. G. GIOVANELLI. *Aust. J. Sci. Res. A.*, **2**, 39–47 (*March*, 1949).

During the growth of sunspots induced electric fields may be expected to be set up in the surrounding atmosphere. It is shown that, because of the comparatively low conductivity perp. to lines of magnetic force, there are localized regions where large space charges occur, resulting in large electric fields perp. to the lines of magnetic force. Consequently both positive and negative charges drift in the same sense in a direction which is at right angles to the electric and magnetic fields, giving rise to a general movement of the gas. The drift velocities are difficult to estimate but appear to be of the order of magnitude of those found in eruptive prominences.

523.75

1408. On the ultra-violet radiation from the solar corona. I. S. MIYAMOTO. *Mem. Coll. Sci., Univ. Kyoto Ser. A*, **25** (*No.* 1) 31–5 (1947).

Weak u.v. radiation emitted by the corona has been calculated. The main factor of the emission is the free-free transition of H. Anomalous excitation of H in the flash spectrum has been investigated in terms of the radiation from the corona. It corresponds to the temp. radiation of 8 000 and 16 500 for the ionization potential of He I and He II respectively. Theoretical intensities of He I lines show a max. at certain height as is known by observation. A

523.83

1409. On an empirical relationship between colour temperature and radiation temperature, derived from eclipsing binaries. W. BECKER. *Z. Astrophys.*, **25** (*Nos* 1–2) 145–60 (1948) *In German.*

In a previous paper [*ibid.*, **19**, 269 (1940)] the author used the Delta Cephei-variables to derive an empirical relation between colour temps. T_F and radiation temps. T_S. He then found for higher temps. $T_S < T_F$, and for lower temps. $T_S > T_F$, in agreement with the demands of the theory. He now makes use of a similar possibility offered by eclipsing binaries showing a total eclipse. Their light curve furnishes the ratio of the radii of both components and the amplitude of the light variation. Planck's law then gives the difference of the T_S-values of both components; these are calculated for 25 eclipsing binaries, for which the spectra of both components, and therefore also their colour temps., are known. The T_S–T_F-relation is thus derived, the known data for the sun fixing its zero-point. The agreement with the former Delta Cephei results is satisfactory, as well as the comparison with results by Pilowski and Kuiper obtained in quite a different manner, and with theoretical work by Wildt and Chandrasekhar and Münch. The results are the same for dwarfs as for giants. The hope is expressed that astrophysics may now have soon at its disposal a really reliable scale of colour and radiation temps. A. BEER

523.821.5

1410. Flare of a dMe star, $BD + 20°2465$, observed photoelectrically. K. C. GORDON AND G. E. KRON. *Publ. Astr. Soc. Pacif.*, **61**, 210–14 (*Oct.*, 1949).

A light-curve for measurements at $\lambda 5200$ shows a sudden increase of at least 0·4 mag. and fall to 0·2 mag. above normal in a time of about 5 min. Subsequent decay to normal intensity is such that

excess intensity is an exponential function of time, indicating that the thermal energy of the eruption is lost by radiation alone. If the whole star is involved in the increase, a temp. rise of 40°K would suffice to explain the observations, but observations of the brightening of the continuum in the blue with similar stars [Joy and Humason, *ibid.*, **61**, 133 (1949)] and the rapidity of the cooling suggest that only a small fraction of the projected disc of the star is involved; the relationship between supposed fractional area of disc involved and the required temp. rise is given.

M. W. OVENDEN

523.83

1411. The dynamics of star streaming. P. STEHLE. *Astrophys. J.*, **110**, 250–60 (*Sept.*, 1949).

The hydrodynamical model of a stellar system has had its most detailed discussion in the hands of Chandrasekhar. This treatment consists of smoothing out the mass distribution into one possessing no granular structure and of considering the possible states of such distributions. This can be done in a most elegant and compact way if advantage is taken of the notation and methods of the tensor calculus; for the equation of continuity in phase space can, under the assumptions made by Chandrasekhar, be broken down into 4 sets of equations having, in the static case at least, immediate geometrical interpretation. The object of this paper is to formulate the theory from this geometrical point of view. A.

523.832

1412. New radial velocities of nineteen bright members of the Ursa Major cluster and the space motion of the nucleus stars. R. M. PETRIE. *Publ. Dom. Obs., Ottawa*, **8** (*No.* 2) 117–28 (1949).

523.841

1413. Three magnetic variable stars showing reversal of polarity. H. W. BABCOCK. *Publ. Astr. Soc. Pacif.*, **61**, 226–7 (*Oct.*, 1949).

523.841.3

1414. Spectroscopic observations of the short-period variable Al Velorum. G. H. HERBIG. *Astrophys. J.*, **110**, 156–9 (*Sept.*, 1949).

523.841.3

1415. The spectroscopic binary VV Orionis (HD 36695). O. STRUVE AND W. J. LUYTEN. *Astrophys. J.*, **110**, 160–5 (*Sept.*, 1949).

523.841.3

1416. Spectra of the brighter variables in globular clusters. A. H. JOY. *Astrophys. J.*, **110**, 105–16 (*Sept.*, 1949).

Spectrograms of 35 variables of high luminosity in 14 globular clusters were obtained with low dispersion. Membership in the clusters was tested by measures of radial velocity, which were compared with the velocities obtained at Lick from the integrated light of the clusters. A tabulation of the stars according to period and physical characteristics indicates that the globular clusters contain, in addition to the *RR* Lyrae stars, several variables of 4 definite groups: short period (1–2) days, *W* Virginis, *RV* Tauri (with high luminosity), and irregular or semiregular variables (period 60–110 days). Cepheids, Mira stars, and semiregular variables (types *M*4–*M*6) are rare or absent. In general, the variables found in the clusters correspond to those of population II. A.

523.841.32

1417. The spectrum of R Coronae Borealis at the 1948–1949 minimum. G. H. HERBIG. *Astrophys. J.*, **110**, 143–55 (*Sept.*, 1949).

523.841.9

1418. A photoelectric study of the eclipsing variable BD + 31°3932. Å. WALLENQUIST. *Ark. Astr.*, **1** (*Paper* 6) 59–67 (1949).

523.842

1419. The spectrographic orbits and dimensions of H.D. 171978. R. M. PETRIE. *Publ. Dom. Obs., Ottawa*, **7** (*No.* 27) 415–18 (1949).

523.842

1420. The spectrographic orbit of H.D. 198784. T. S. JACOBSEN and R. P. KRAFT. *Publ. Dom. Obs., Ottawa*, **8** (*No.* 3) 129–34 (1949).

523.842

1421. The spectrographic orbits and dimensions of the eclipsing binary H.D. 193611. J. K. MCDONALD. *Publ. Dom. Obs., Ottawa*, **8** (*No.* 4) 135–40 (1949).

523.842.3

1422. Fifth catalogue of the orbital elements of spectroscopic binary stars. J. H. MOORE AND F. J. NEUBAUER. *Lick Obs. Bull.* (*No.* 521) 1–31 (1949).

523.851.2

1423. On the dynamics of galactic clusters. U. VAN WIJK. *Ann. Astrophys.*, **12**, 81–95 (*April–June*, 1949) *In English.*

The first part of a paper dealing with the dynamics and evolution of galactic clusters, with the purpose of finding the consequences of the virial theorem while the cluster is not necessarily in equilibrium. The differential rotation of the galactic system has been taken into account. The only assumption regarding the random motions is that the contributions to the total kinetic energy due to the $\xi -$, $\eta -$ and $\zeta -$ components of the random velocities are equal. The systematic internal motions have been neglected entirely, which amounts to neglecting the rotation of the cluster. In the first section it is shown that a homogeneous ellipsoidal cluster revolving in a circular orbit around the centre of the galaxy will have a shape given by Mineur's equation [*ibid.*, **2** (*No.* 1) (1939)]. This result is extended in the second section to include non-homogeneous clusters, and it is found that their shapes will still be determined by Mineur's equation. Formulae for the density are obtained, and values required for the equilibrium of a cluster are discussed. The relation between density and the dispersion of the proper motions is derived, the resulting formula being only slightly different from the result obtained by Mineur by a different method of analysis for clusters in statistical equilibrium. Finally this relation is used to obtain the masses of the Pleiades and of Praesepe from the dispersion of the proper motions, and it is found that the mass of a cluster derived in this way is virtually independent of the density distribution. A.

523.851.4

1424. The Ursa Major group. N. G. ROMAN. *Astrophys. J.*, **110**, 205–41 (*Sept.*, 1949).

523.852.21

1425. Color excess, total photographic absorption, and the distance of the dark cloud in the Aquila region of the Milky Way. H. F. WEAVER. *Astrophys. J.*, **110,** 190–204 (*Sept.*, 1949).

523.852.22

1426. The radiative equilibrium of a spherical planetary nebula. H. K. SEN. *Astrophys. J.*, **110,** 276–87 (*Sept.*, 1949).

523.854.12

1427. Remarks on the evolution of the interstellar clouds. E. SCHATZMAN. *Ann. Astrophys.*, **12,** 161 (*April–June*, 1949) *In French.*

It is suggested that supergiants, whose short lifetimes require a process of continual formation, evolve by the contraction of interstellar clouds caused by radiation pressure on the particles. It is shown that during such a contraction, the cloud does not completely carry with it the interstellar H, and the progressive decrease in the proportion of H in the contracting globule would lead to a supergiant deficient in H and He compared with a normal star. but it is difficult to assess the magnitude of the deficiency.

M. W. OVENDEN

523.854.12

1428. New investigations of the interstellar matter. C. SCHALÉN. *Naturwissenschaften*, **36** (*No.* 2) 33–41 (1949) *In German.*

Critical discussion of methods and results since the first development of this new field, i.e. since about 1930. Amplification of the author's own contributions in *Uppsala Obs. Ann.*, **1,** 2 (1939), **1,** 9 (1945), **2,** 5 (1948), *Naturwissenschaften*, **28,** 81 (1940), and *Harvard Obs. Monographs*, **7,** 11 (1948). He deals with the properties of the absorbing clouds, the investigations in the red and i.r. into the nature of the interstellar particles, the splitting of interstellar lines into two or more components, with the attempts to calculate the number of particles of the various chemical elements in space, and with the problems of their origin and the formation of stars out of interstellar matter. A. BEER

523.855

1429. The upper limit in size of the spiral nebulae. C. F. v. WEIZSÄCKER. *Naturwissenschaften*, **35** (*No.* 6) 188–9 (1948) *In German.*

On the basis of the author's theory [Abstr. 1390 (1948)], all accumulation of cosmic matter can be explained by turbulence and gravitation. The existence of a max. size of a galaxy is now traced back to a combined effect of turbulence and the expansion of the universe. An empirical test is suggested and satisfied: the statistical dispersion of the relative velocities of the largest extragalactic nebulae should be comparable with the relative velocities derived for them from Hubble's relationship which governs the expansion velocities. Thus, e.g., the observed relative velocity of about 300 km/sec between our Milky Way and the Andromeda nebula has been given a theoretical significance. A. BEER

523.87 : 523.57

1430. Sodium D in the spectrum of meteors. F. E. ROACH. *Astrophys. J.*, **110,** 314 (*Sept.*, 1949).

It is concluded that the Na *D* line in meteoric spectra may be due to atmospheric Na atoms if the effective thickness of the region activated by the meteor is greater than about 300 cm. A.

523.87

1431. Interstellar calcium lines in the spectra of stars in open clusters. R. F. SANFORD. *Astrophys. J.*, **110,** 117–25 (*Sept.*, 1949).

Distances of 31 open star clusters have been derived from the equivalent widths of the interstellar lines in the early-type stars. Velocities which have been obtained from both the interstellar and the stellar lines accord with differential galactic rotation. The distances have been derived by means of both stellar and interstellar velocities. Although the correlation of these distances with the corresponding equivalent widths is not especially good, it seems to be considerably better than the correlation of Trumpler's distances with equivalent width. The equivalent widths and both the stellar and the interstellar velocities seem, therefore, to provide a useful means of obtaining the distances of open clusters. The stellar and interstellar velocities of 14 stars provide good evidence that they belong to the h and χ Persei clusters. A.

523.874

1432. A photometric study of the spectrum of Pleione. A. B. UNDERHILL. *Astrophys. J.*, **110,** 166–81 (*Sept.*, 1949).

523.874

1433. Luminosity distribution and proper motions of tenth-magnitude K stars. F. K. EDMONDSON, A. N. VYSSOTSKY AND E. M. JANSSEN. *Astrophys. J.*, **110,** 182–9 (*Sept.*, 1949).

Absolute luminosities and proper motions have been determined for 681 *K* stars between 10·0 and 11·0 photovisual magnitude in a sampling of the entire sky north of $-25°$. It is found that some 85% of these stars in low latitudes are giants, and approximately 75% in higher latitudes. Thus the galactic concentration of the *K* giants is very low. Since the dispersions in the motions of the higher-latitude giants and their group motion with respect to the sun appear to be considerably $>$ average, it is inferred that they are characterized by larger-than-average eccentricities in their orbits around the galactic centre. A.

523.875

1434. Magnetic intensification of stellar absorption lines. H. W. BABCOCK. *Astrophys. J.*, **110,** 143–55 (*Sept.*, 1949).

The total intensity of a saturated absorption line may be increased several fold in a magnetic field of a few kilogauss because the Zeeman pattern may be considerably wider than the thermal Doppler profile. The effect should be particularly marked for lines having wide, anomalous Zeeman patterns of many components; it is enhanced for elements of high atomic weight at reduced temps. and in the absence of turbulence. An upper limit to the intensification factor is $\frac{1}{2}$ the number of components in the Zeeman pattern of the line. A method is developed for computing the magnetic intensification, W_z/W_0, for a saturated line of given pattern in integrated light of a star viewed from the direction of the pole ($i = 0°$)

or viewed from the plane of the star's equator ($i = 90°$). For the line Fe I λ4260, having a triplet pattern ($Z = 1 \cdot 60$), $W_z/W_0 = 1 \cdot 25$ for a field of 8 kilogauss and a temp. of 10 000°. The intensification factor appears to be essentially independent of i; it may approach 7 for an exceptional line like Eu II λ4205, which has 21 widespread components. If equivalent widths can be measured, it should be possible in principle to estimate stellar magnetic field strengths by detailed comparisons of lines selectively intensified by Zeeman splitting, even if pronounced rotational broadening is present. In a number of the peculiar stars of type *A*, magnetic fields ranging up to several kilogauss have been measured with the polarizing analyser; the conclusion is practically inescapable that magnetic intensification must contribute to the abnormal line intensities in the spectra of some of these stars. For about 50 lines in the spectrum of α^2 *CVn*, for which intensity estimates at 3 phases of the spectral variation have been published by Struve and Swings, the degree of observed intensity variation is compared with the magnetic intensification factor predicted from the Zeeman patterns; a satisfactory correspondence is found. A.

523.876

1435. Variation of the Balmer discontinuity in δ Cephei, η Aquilae and ζ Geminorum. I. R. CANAVAGGIA. *Ann. Astrophys.*, **12** (*No.* 1) 21–38 (1949) *In French.*

Observations of gradients in the visual region (relative to comparison stars) are tabulated, in addition to the Balmer discontinuities for these 3 Cepheid variables. Variations with phase are discussed. For δ Cephei, monochromatic light curves at 10 wavelengths give amplitudes which are compared with values from other sources and discussed as a function of $1/\lambda$. Ultraviolet gradients are also given for this star. D. L. EDWARDS

523.876

1436. Variation of the Balmer discontinuity for δ Cephei, η Aquilae, ζ Geminorum. II. R. CANAVAGGIA. *Ann. Astrophys.*, **12** (*No.* 2) 96–122 (1949) *In French.*

Spectrophotometric measures of the "Balmer jump," D, in the spectra of the Cepheid variables, δ Cephei, η Aquilae and ζ Geminorum are utilized to study the variation with phase of the electronic pressure, p, and of the effective gravity, G. For δ Cephei, it is shown that, for the same effective temperature, T, values of p, and G are smaller in the early phase of the cycle than in the later phase. Values of D, expressed as function of T, used in this investigation, are those derived in Part I of the paper. D. R. BARBER

523.877

1437. On the use of mean coefficients of absorption in the theory of stellar atmospheres. R. MICHARD. *C.R. Acad. Sci., Paris*, **229**, 702–4 (*Oct.* 10, 1949) *In French.*

Temp. is calculated as a function of pressure for model solar atmospheres using Rosseland, Chandrasekhar and Planck mean absorption coeffs. An intermediate model is constructed for which the integrated flux is accurately constant. R. A. NEWING

523.877

1438. The transfer of radiation in a spherical atmosphere of electrons. M. H. WRUBEL. *Astrophys. J.*, **110**, 288–302 (*Sept.*, 1949).

The emergent intensities in the two components of polarized light are determined for the case of an extended spherical atmosphere of electrons resting on a photosphere which emits unpolarized radiation. The problem is solved in an approximation which includes terms through $P_3(\mu)$ in an expansion in spherical harmonics and for an atmosphere extending to infinity, in which the opacity varies inversely as the square of the radius. Atmospheres are considered with total optical thicknesses, τ_{fl}, of $0 \cdot 5$, $1 \cdot 0$ and $2 \cdot 0$. It is found that the polarization of the scattered light varies from zero at the centre of the star to 19, 16 and 11% at the edge of the photosphere for $\tau_1 = 0 \cdot 5$, $1 \cdot 0$ and $2 \cdot 0$, respectively. Beyond the discontinuity at the photosphere, the degree of polarization remains practically constant, decreasing slowly from 22% for $\tau_1 = 0 \cdot 5$, increasing from 19 to 20% before decreasing for $\tau_1 = 1 \cdot 0$, and increasing from 13 to 20% and then decreasing for $\tau_1 = 2 \cdot 0$. In every case the degree of polarization is approximately 20%, decreasing slowly at 10 radii from the centre of the star. A.

523.877

1439. Regions with varying mean molecular weight (white dwarfs with complex structures). E. SCHATZMAN. *Astrophys. J.*, **110**, 261–75 (*Sept.*, 1949).

The presence of metallic lines in the spectrum of certain white dwarfs seems inconsistent with the assumption of gravitational sorting of the elements in the outer, nondegenerate part of these stars. The theory of this sorting, which has been developed previously, is used to analyse this problem. For simplification, the elements other than H have been replaced by a mean element, which has been taken to be O. The results indicate that, unless the metallic abundance is very high or very low, a stable equilibrium is not easily reached, since the rapid increase of the opacity with depth, due to the increase of the metallic concentration with depth, makes the radiative layer unstable against convection. A model compatible with the observed energy production and the presence of metallic lines in the spectrum of van Maanen 2 is derived on this basis. A.

523.877

1440. Magnetic oscillations of a highly idealized star. M. SCHWARZSCHILD. *Ann. Astrophys.*, **12**, 148–60 (*April–June*, 1949) *In English.*

Magneto-hydrodynamic oscillations of an entire star are considered as a possible explanation of the observed variations in the magnetic fields of spectrum variables. Solutions of the relevant basic equations are derived under greatly idealized approximations. In rough comparisons with observation no serious discrepancies are found. A.

523.877

1441. On a method for the study of the absorbing properties of stellar atmospheres. R. CANAVAGGIA, D. CHALONGE AND V. KOURGANOFF. *C.R. Acad. Sci., Paris*, **229**, 108–9 (*July* 11, 1949) *In French.*

Further development of Kourganoff's analysis

[Abstr. 6727 (1949)], which introduced for each wavelength λ a temperature T satisfying conditions that make the optical depth $\tau_\lambda = 2/3$. For the sun the max. opacity is found at 9 000 Å, with the min. value of $T = 5\,700°$, and the min. opacity at 16 000 Å, with the max. $T = 6\,550°$. The importance of T is shown; it correlates the variations of the absorbing properties of stellar atmospheres with the changes of colour temps. with wavelength. A. BEER

523.877

1442. Wave lengths, equivalent widths, and line profiles in the spectrum of the star H.D. 190073. C. S. Beals and M. S. Burland. *Canad. J. Res. A*, **27**, 169–90 (*Sept.*, 1949).

With the aid of long exposures (18 and 25 hr respectively) the spectrum in the ordinary region has been photographed with dispersions of 7·3 to 15·2 Å/mm. The resulting spectrograms revealed approximately 100 stellar lines not observed with single-prism dispersion as well as indicating more clearly the structure of a number of complex line profiles. Wavelengths, identifications and equivalent widths are listed for all observed lines, and a number of the more interesting line profiles are illustrated. The interpretation of line profiles is discussed and it is pointed out that the presence of asymmetrical H lines is an indication of a shell of relatively small diameter. A.

523.877 : 539.155.2

1443. Isotopes in stellar atmospheres. A. McKellar. *Publ. Astr. Soc. Pacif.*, **61**, 199–209 (*Oct.*, 1949).

The general problem of detecting the presence of isotopes in stellar atmospheres is discussed. The relatively few cases for which information can be obtained are noted and the present situation for each is briefly reviewed. The case of C^{12} and C^{13} in the *R*- and *N*-type stars is treated in some detail. A.

525.35 : 529.7

1444. The irregularity of the rotation of the earth and the astronomical clocks. N. Stoyko. *Bull. Acad. Roy. Belg. Cl. Sci.*, **35** (*No.* 7) 669–70 (1949) *In French.*

The study of the results of the time service of 14 observatories, obtained during the period Jan., 1946, to April, 1947, and of irregularities observed at Washington, leads to the formula:

$$\Delta t = -0^s{\cdot}00112 \sin (t + 3^h{\cdot}2) + 0{\cdot}00048 \sin 2(t + 2^h{\cdot}0)$$

(where t is counted from Jan. 15 in units of 15 days), representing a periodic change in the rotation of the earth (besides accidental irregularities). Similar results were formerly noticed by the author for the period 1934–37, differing in amplitude from the new results by $< 0{\cdot}0001$ sec. A. BEER

525.35 : 529.7

1445. On the fluctuations of the annual period of the earth's rotation. F. H. van den Dungen, J. F. Cox and J. van Mieghem. *Bull. Acad. Roy. Belg. Cl. Sci.*, **35** (*No.* 7) 642–55 (1949) *In French.*

A theory and numerical comparisons are given to establish the existence of a yearly period in the earth's moment of inertia, in order to account for the time-service results of Stoyko. These observations imply that, in terms of a mean daily rotational period, the earth "goes slow" by 0·07 sec in June and fast by 0·06 sec in October, so that the daily increase corresponds to about 0·001 sec. Quantitative considerations of the mean structure and seasonal meteorological changes in the distribution of the total air masses involved show that these factors may be relevant to explain the observed rotational fluctuations. A. BEER

526.17

1446. The regional rise of the geoid in Central Europe. L. Tanni. *Ann. Soc. Sci. Fennicae, Ser. A III*, **20** (*No.* 20) 5–18 (1949) *In English.*

526.6

1447. On the determination of the absolute and relative position of Europe and America on the globe. A. Berroth. *Geofis. Pura Appl.*, **15**, 20–6 (*July–Sept.*, 1949) *In German.*

Improvements are put forward in a hitherto neglected method first given by F. R. Helmert [in *Phys. Theor.*, **2**, 451–60 (1884)]. The projection of the full moon on the celestial sphere is observed and compared with the predicted geocentric position. The author amplifies Helmert's theory, uses Sundman's new accurate formulae (1948) for the moon's position, and replaces certain absolute corrections by relative ones. He also evaluates one of the unknowns by an independent method. A. BEER

526.774

1448. On the absolute measurement of gravity. H. Jeffreys. *Mon. Not. Roy. Astr. Soc., Geophys. Suppl.*, **5**, 398–408 (*Oct.*, 1949).

A simplified method is given for finding the corrections for bending and stretching of a pendulum used for making an absolute determination of gravity. It appears that the correction given by Clark [*Philos. Trans. A*, **238**, 65 (1940)] is incorrect and that the value of g for Teddington consequently needs an increase of about 1·7 mgal. Examination of several minor corrections mentioned by Heyl and Cook for the Washington determination shows that they accumulate and that the value given by these authors also needs an increase of about 1·5 mgal. When taken in conjunction with the relative determination by Bullard and Browne, the revised values give a discrepancy of $4{\cdot}7 \pm 1{\cdot}6$ mgal, which is large enough to need attention. An independent determination is desirable. A.

526.918

1449. Applications of the general theory of the curvature of the field of optical systems to photogrammetric problems. M. di Jorio. *Ottica*, **2**, 13–20 (1948) *In French.*

An equation is derived which connects object and image curvature for finite object and field. This is a generalization of the well-known Petzval theorem. The method involves the use of formulae which compute sagittal and meridional curvature for meridional rays of finite aperture. MATHEMATICAL REVIEWS

526.943 : 533.43

Elevation surveying by precision barometer. *See Abstr.* 1565

529.78

1450. Rate variations of Schuler-clocks due to periodic forces, earth disturbances and variations of the pendulum length. C. HOFFROGGE. *Z. Phys.*, **126** (*Nos* 7–9) 671–88 (1949). Also *Naturwissenschaften*, **36** (*No.* 10) 312 (1949) *In German.*

The errors and rates of two Schuler pendulums are compared with a quartz clock with a precision of $\pm 0{\cdot}05$ msec. Variations of rate due to lunar changes of gravity are observed. During the 25 hr cycle they amount to 10 msec/d, although the error in 1 day is $< \pm 1$ msec. Earth vibrations cause occasional sudden changes of 55 msec and frequent smaller disturbances. Changes of rate are observed equivalent to changes in the length of the pendulums of $0{\cdot}1\ \mu$ in 8 days. L. ESSEN

PHYSICS 53

53.087

1451. High-speed recording by a rotating mirror method. J. D. OWEN AND R. M. DAVIES. Letter in *Nature, Lond.*, **164,** 752 (*Oct.* 29, 1949).

The propagation of torsional waves in steel cylinders was studied by reflecting a narrow pencil of light on a minute optical flat polished on the surface of the bar. The reflected ray was directed to a mirror rotating at 1 000 r.p.s., driven by a high-speed air turbine, and records were obtained on film fixed on a circular arc. The radius of the arc was 27 cm, and a writing speed of 3 mm/μsec was obtained. The light source was a Hg flash tube, energized by the discharge from a condenser, and giving a flash duration of 100 μsec. The stress pulse, consisting of torsional waves, was initiated by firing a rifle bullet at a suitable point on a flat surface machined on one end of the bar. A. C. WHIFFIN

FUNDAMENTALS 530.1

530.12

1452. Fermi statistics in the relativity theory. K. SZÉLL. *Hungar. Acta Phys.*, **1** (*No.* 4) 19–27 (1949) *In German.*

The degenerate ideal gas is treated. The method, unlike the earlier treatment by Jüttner [*Z. Phys.*, **47,** 542 (1928)], is not limited to the case of weak degeneracy. P. M. DAVIDSON

530.12

1453. Conceptions of space and the mechanics of the electron. F. BUREAU. *Bull. Acad. Roy. Belg. Cl. Sci.*, **35** (*No.* 6) 542–58 (1949) *In French.*

Starting from considerations of unified theories, an examination of field equations is made, leading to the conclusion that any simple hyperbolic equation of the 2nd order, representing a wave phenomenon, can be put into correspondence with a Riemannian metric, a 4-potential and a 1st-order partial differential equation of the second degree, representing the particle aspect of the phenomenon. The same can be done for systems of 1st-order equations, such as the Dirac equation, which are totally hyperbolic. G. J. KYNCH

530.12

1454. On the influence of the metric field on a scalar material field. W. SCHERRER. *Helv. Phys. Acta*, **22** (*No.* 5) 537–51 (1949) *In German.*

Field equations are derived from a variation principle with action-density

$$\left\{(R - 2\Lambda)\psi^2 + 4\omega g^{\rho\sigma}\frac{\partial\psi}{\partial x^\rho}\frac{\partial\psi}{\partial x^\sigma}\right\}\sqrt{(-g)}$$

where ψ^2 is a "relative intensity" of matter associated with each point of space-time. The energy tensor is identified with an expression involving ψ^2. Static, spherically symmetric solutions obtained for $\Lambda = \omega = 0$, have a singularity at the origin, but have finite total energy. R. A. NEWING

530.145

1455. Some theorems on perturbation theory. E. C. TITCHMARSH. *Proc. Roy. Soc. A*, **200,** 34–46 (*Dec.* 22, 1949).

It is proved that the well-known formulae which give the variation in the eigenvalues and eigenfunctions arising from a differential equation $\phi''(x) + \{\lambda - q(x)\}\phi(x) = 0$, when $q(x)$ is varied, are valid under certain general conditions. The analysis is extended to partial differential equations. A.

530.145

1456. Possible types of nonlocalizable fields. H. YUKAWA. Letter in *Progr. Theor. Phys.*, **3,** 452–3 (*Oct.–Dec.*, 1948).

Field quantities are derived for several scalar, neutral fields of zero mass particles, satisfying the conditions of reciprocity previously established [Abstr. 48 (1950)]. Extension to vector fields is simple. G. J. KYNCH

530.145

1457. Examples in which the perturbation method fails. T. KATÔ. Letter in *Progr. Theor. Phys.*, **3,** 313–14 (*July–Sept.*, 1948).

Some simple examples are given where the eigenvalue is not expressible as a power series in the interaction constant, and perturbation gives either "divergent" terms or not, depending on the zero-order approximation. G. J. KYNCH

530.145

1458. On the Lorentz covariance of the field equations. V. VOTRUBA. *Rozpravy II. Třídy České Akad.*, **56** (*No.* 11) 23 *pp.* (1946) *In Czech.*

The spinor calculus is used to find all transformation rules for field functions which leave a certain set of field equations covariant under Lorentz transformations. For the Frenkel–Madelung equations for particles with zero rest-mass, 6 rules are found. MATHEMATICAL REVIEWS

530.145

1459. On the spin-spin interaction. P. L. FERREIRA. *An. Acad. Brasil. Ciênc.*, **21** (*No.* 3) 181–90 (1949) *In Portuguese.*

It is shown that Fermi's hyperfine-structure formula can be considered as an application of Møller's formula to *s*-states. The interaction electron-positron, in non-relativistic approximation is equi-

valent to a superposition of electric and magnetic dipoles. Finally, one can show that the Møller–Rosenfeld mixture of nuclear forces corresponds, closely, in the case of a meson field, to the electromagnetic interaction between electron and positron.

A.

530.145

1460. Radiative corrections to nuclear forces in the pseudoscalar meson theory. K. M. WATSON AND J. V. LEPORE. *Phys. Rev.*, **76**, 1157–63 (*Oct.* 15, 1949).

The fourth-order corrections to nuclear forces in the charged and symmetrical pseudoscalar meson theories are obtained by the Feynman–Dyson method. All infinite parts are reconciled in terms of renormalization of mesonic and nucleonic mass and charge. The potentials obtained by a non-relativistic approximation yield ordinary spin-independent forces which behave as $1/r^3$ in the non-relativistic region. This singularity is reduced to $1/r$ by relativistic effects. The potentials are in disagreement with experiment, but the neutron-proton scattering problem is treated in order to obtain insight into the nature of relativistic corrections at 90 MeV, and it is shown that they are not small.

A.

530.145

1461. Note on the relativistic formulation of Belinfante's transformation. Y. KATAYAMA AND S. TAKAGI. Letter in *Progr. Theor. Phys.*, **4**, 240–2 (*April–June*, 1949).

The electromagnetic field is treated as a vector meson field with vanishingly small meson mass. Elimination of the longitudinal field is then carried out in an invariant way using Tomonaga–Schwinger methods.

E. P. GEORGE

530.145

1462. On a pair of reciprocal de Sitter spaces. S. WATANABE. Letter in *Progr. Theor. Phys.*, **3**, 450–2 (*Oct.–Dec.*, 1948).

The "reciprocal" of the 5-dimen. formulation of relativistic quantum theory [Abstr. 1689 (1949)] is to regard the energy-momentum space as a hyperbolic space embedded in a flat 5-dimen. space. Space-time operators can be defined with results similar to those of Snyder [Abstr. 2014 (1948)]. The relation between the space-time and the momentum-energy spaces is discussed tentatively.

G. J. KYNCH

530.145

1463. On the relativistic formulation of the perturbation theory. Y. NAMBU. Letter in *Progr. Theor. Phys.*, **3**, 444–5 (*Oct.–Dec.*, 1948).

An operator method is suggested, to deal with integrations in the subtraction covariant field theories.

G. J. KYNCH

530.145

1464. The self-consistent subtraction method and Heitler's integral equation. T. MIYAZIMA. Letter in *Progr. Theor. Phys.*, **3**, 455–6 (*Oct.–Dec.*, 1948).

The integral equation is derived, as an approximation, in an invariant way from the equations of the subtraction, many-time field formalism.

G. J. KYNCH

530.14

1465. On Dirac's generalised transformation functi tion. IIa. S. WANATABE. *Progr. Theor. Phys.*, 3 378–90 (*Oct.–Dec.*, 1948).

The transformation to quantum mechanics of th classical theory already developed [Abstr. 295 (1949)] is considered, together with commutation rules and conservation laws.

G. J. KYNCH

530.145

1466. On Dirac's general transformation function IIb. S. WANATABE. *Progr. Theor. Phys.*, **4**, 1–1 (*Jan.–March*, 1949).

Continuation of Abstr. 1465 (1950). It is concluded that the classical and the quantum transformation in the Hamilton formulation can be constructed in a domain in space-time bounded by two-space like surfaces which are a finite distance apart. A further generalization is not possible without going beyond the assumptions of the existing field theory.

G. J. KYNCH

530.145

1467. On the meson pair theory of nuclear forces in the interaction representation. S. KANESAWA. Letter in *Progr. Theor. Phys.*, **4**, 238–9 (*April–June*, 1949).

The interaction of the previous paper [Abstr. 706 (1950)] is used to calculate the nucleon interaction. Details are not given. An inverse-cube singularity is obtained at the origin.

E. P. GEORGE

530.145

1468. Divergence difficulties and mixed meson theory. II. G. ARAKI. *Progr. Theor. Phys.*, **4**, 34–41 (*Jan.–March*, 1949).

Continuation of Abstr. 5252 (1949). The conclusion of an earlier letter [Abstr. 4472 (1949)] is slightly modified, after examination of all possible couplings with two types of meson. A vector-pseudovector mixture also satisfies the stated conditions, in addition to the pseudoscalar-pseudovector mixture.

G. J. KYNCH

530.145

1469. The self-energy of a Dirac particle and its relativistic covariance. R. KAWABE AND H. UMEZAWA. Letter in *Progr. Theor. Phys.*, **4**, 370–1 (*July–Sept.*, 1949).

The self-energy is covariant when calculated by perturbation theory together with a suitable cut-off [Abstr. 1470 (1950), 3966 (1949)]. The self-energy due to the electromagnetic field is that obtained by the Schwinger method and the self-energy of the interaction with a C-meson (scalar) field is identical with that given by Pais [Abstr. 2480 (1946)] as the mass difference between the proton and neutron.

G. J. KYNCH

530.145

1470. An improvement on the integrations appearing in perturbation theory. H. UMEZAWA AND R. KAWABE. Letter in *Progr. Theor. Phys.*, **4**, 367–8 (*July–Sept.*, 1949).

To obtain covariance integrals over two momenta p_1, p_2 are evaluated over a surface defined by the scalar product $P_1 \cdot P_2$ of the two 4-vectors P_1, P_2 whose space parts are p_1, p_2. This replaces the usual integration over a sphere in momentum space [Abstr. 3966 (1949)].

G. J. KYNCH

530.145

1471. On the method of third quantisation. I. Y. NAMBU. *Progr. Theor. Phys.*, **4**, 331–46 (*July–Sept.*, 1949).

In recent electrodynamics the separation of fluctuation terms can be carried out by re-ordering the field operators so that all emission operators $\psi^x(x)$ stand before the absorption operators $\psi(x)$. Such a well-ordered operator containing n absorption and n' emission operators can be regarded as a vector in a sub-space of $n + n'$ dimensions. A further field ψ or ψ^x multiplying this vector acts as an operator in this space. The properties of this space, operators and their eigenvalues are discussed for Fermi or Bose particles, the eigenvalue problem of an operator A being put in the form $AX - XA = \lambda X$. From this point of view the unitary transformation U in the Schwinger–Tomonaga theory appears as a vector satisfying a Schrodinger equation. G. J. KYNCH

530.145

1472. General formulae appearing in the problem of vacuum polarisation. H. UMEZAWA AND R. KAWABE. Letter in *Progr. Theor. Phys.*, **4**, 368–9 (*July–Sept.*, 1949).

By perturbation calculations in the interaction representation, general formulae are found for terms in the induced polarization current, independent of the nature of the particles. These terms are listed. They are discussed for the electron and scalar and vector mesons. The only term likely to cause difficulty is an "observable" term which diverges in the vector meson theory. G. J. KYNCH

530.145

1473. Vacuum polarisation due to various charged particles. H. UMEZAWA AND R. KAWABE. Letter in *Progr. Theor. Phys.*, **4**, 369–70 (*July–Sept.*, 1949).

Using the formulae and a method of integration described earlier, the induced current terms and the corresponding photon energies are given for a Dirac, scalar or vector particle. The conditions to be satisfied for vanishing photon energy when a number of all such fields simultaneously interacts with the Maxwell field are immediately obtained [see Abstr. 7160 (1949)]. G. J. KYNCH

530.145

1474. Magnetic moments of nucleons. K. SAWADA. Letter in *Progr. Theor. Phys.*, **4**, 383–5 (*July–Sept.* 1949).

The neutron and proton magnetic moments have been calculated in the Schwinger formalism, with regulators where necessary, for all the various types of single meson theory [see Abstr. 5949 (1949)]. G. J. KYNCH

530.145

1475. On the self-energy of the neutretto. Y. KATAYAMA. Letter in *Progr. Theor. Phys.*, **4**, 396–7 (*July–Sept.*, 1949).

To compare with a previous result [Abstr. 1498 (1950)] the self-energy of a pseudoscalar neutral meson due to the nuclear field has been obtained, using a regularizing procedure. It is also found to diverge logarithmically. G. J. KYNCH

530.145

1476. The theory of the interaction of elementary particles. I. The method of the theory of elementary particles. S. SAKATA. *Progr. Theor. Phys.*, **2**, 145–50 (*July–Oct.*, 1947).

A discussion of methods leads to the suggestion that the difficulties of field theory may be resolved by investigating the correlations of the interactions of all fields with a given particle and vice versa, rather than dealing with each interaction by itself. G. J. KYNCH

530.145 : 537.12

1477. The theory of interaction of elementary particles. II. The electromagnetic self-energy of the elementary particles. O. HARA. *Progr. Theor. Phys.*, **3**, 188–98 (*April–June*, 1948).

Particles are assumed to act with an electromagnetic field and a neutral scalar meson field [*C*-mesons] simultaneously. By a suitable choice of interaction constants the divergent parts of the first-order term in the self-energy cancel leaving a finite answer. This is shown for charged particles of spin 0, $\frac{1}{2}$ and 1. Higher order terms are not considered. G. J. KYNCH

530.145 : 539.18

1478. The theory of the interaction of elementary particles. III. On the nature of the *C*-meson. O. HARA AND M. TATSUOKA. *Progr. Theor. Phys.*, **3**, 369–77 (*Oct.–Dec.*, 1948).

As a continuation of previous work [preceding Abstr.] the cross-section for the creation of *C*-mesons by photons in the limits of high and low energy of the incident photons is calculated when the scatterer is an electron or a nucleon. Using the Weizsacker–Williams method the cross-section is then given for emission of a *C*-meson in the scattering of a charged particle by a nucleus. Finally the modification of the Coulomb law is found to be a short-range repulsion, causing little deviation from the simpler law. [*Pt IV*, Abstr. 715 (1950)]. G. J. KYNCH

530.145

1479. Theory of the interaction of elementary particles. V. The problem of vacuum polarisation (3). H. UMEZAWA AND E. YAMADA. *Progr. Theor. Phys.*, **4**, 251–62 (*July–Sept.*, 1949).

Charge renormalization is considered for any charged field interacting through the electromagnetic and *C*-meson fields. The divergent terms could be made to cancel and suitable renormalizations made, if all fields were simultaneously considered. The calculations include the 4th-order scattering of a photon by a charged scalar meson, charge renormalization in Compton scattering, the elastic scattering of a charged particle by an electrostatic field and finally the f-charge renormalization of the *C*-meson itself is examined. G. J. KYNCH

530.145

1480. Selection rules for meson problems. H. FUKUDA AND Y. MIYAMOTO. Letter in *Progr. Theor. Phys.*, **4**, 389–91 (*July–Sept.*, 1949).

When nucleons interact with a number of meson fields the terms in the expansion of the transformed Hamiltonian, in the interaction representation, contain products of the interaction terms. If N_v of these are vector couplings, N_t tensor couplings and N_s is the number of isotopic spin components τ_s

in the product, the matrix element of any transition is zero if $N_\nu + N_t + N_s$ is an odd number, i.e. this process is forbidden. If only neutral mesons are involved this reduces to the requirement that $N_\nu + N_t$ be an odd number. If the electromagnetic interaction is included no general rules can be given except that mentioned earlier for neutral mesons [Abstr. 1495 (1950)]. G. J. KYNCH

530.145

1481. A divergence-free field theory. K. SAWADA. Letter in *Progr. Theor. Phys.*, **4**, 374–5 (*July–Sept.*, 1949).

530.145 : 531.19

1482. A general theorem on the transition probabilities of a quantum mechanical system with spatial degeneracy. H. A. TOLHOEK AND S. R. DE GROOT. *Physica*, **15**, 833–42 (*Oct.*, 1949) *In English.*

In the general case of a quantum mechanical system with a Hamiltonian that is invariant for rotations spatial degeneracy will exist. Thus the initial state must be characterized except by the energy, also by, e.g., the magnetic quantum number. Both for emission of light and electrons plus neutrinos (β-radioactivity) of a quantum mechanical system the following theorem is important: the total transition probability from an initial level with some definite magnetic quantum number m_i to every possible final level belonging to one energy does not depend on m_i. A simple proof is given for this theorem that embraces the case of forbidden transitions, which case is not covered by the usual proof. In the proof a Gibbs ensemble of quantum mechanical systems is used; the necessary and sufficient conditions for the rotational invariance of such an ensemble are given. A.

530.145 : 537.12

1483. The theory of the Dirac electron, in momentum space. M. LÉVY. *C.R. Acad. Sci., Paris*, **229**, 985–7 (*Nov.* 15, 1949) *In French.*

Some additional properties of the solutions with a Coulomb field are mentioned, other than those given by Rubinowicz [Abstr. 2718 (1948)]. A comparison with the non-relativistic solutions in momentum space is made. G. J. KYNCH

530.145 : 537.122

1484. External vacuum polarization. Z. KOBA. Letter in *Progr. Theor. Phys.*, **4**, 382–3 (*July–Sept.*, 1949).

Mention is made of the disadvantages of defining the vacuum in terms of eigenfunctions of a Hamiltonian with an external potential [Abstr. 5416 (1949)]. G. J. KYNCH

530.145 : 537.122

1485. Note on the finite extension of the electron. K. SAWADA. *Progr. Theor. Phys.*, **4**, 275–86 (*July–Sept.*, 1949).

The analysis of the electron self-energy by elementary methods [see Abstr. 3149 (1939)] shows that it can be expressed as an interaction due to a finite extension, with form functions due to the radiation reaction and that due to vacuum fluctuation effects. The mean radius for the latter is the Compton wavelength. Picking out matrix elements suitably, the Lamb shift is obtained in non-relativistic approx. G. J. KYNCH

530.145 : 537.533.7

1486. Radiation reaction in collision processes. I Z. KOBA AND G. TAKEDA. *Progr. Theor. Phys.*, 407–21 (*Oct.–Dec.*, 1948).

The e^2 correction terms to the Klein–Nishin formula are obtained by perturbation theory an classified. They are examined and modifications t the Hamiltonian are found which remove infinitie Some of these can be subtracted as mass or charg renormalization terms, but the remainder is a vacuu polarization term which cannot be reasonably inter preted in this way. The introduction of an auxiliar meson field does not affect this term. G. J. KYNC

530.145 : 537.12 : 537.533.7

1487. Radiation reaction in collision processes. III Z. KOBA AND G. TAKEDA. *Progr. Theor. Phys.*, 4 60–70 (*Jan.–March*, 1949).

The modified Hamiltonian [Abstr. 1486 (1950)] derived from considerations of Compton scattering and mutual scattering of electrons, is found to be effective in eliminating divergences from the first order corrections to any process, whatever order in the zero-order term may be. Such general processes include, e.g. double Compton scattering. To this end a transition diagram method is adopted for sorting out various types of transition schemes.

G. J. KYNCH

530.145 : 538.3

1488. Auxiliary condition and gauge transformation in the 'super-many-time' theory. II. Z. KOBO Y. ÔISI AND M. SASAKI. *Progr. Theor. Phys.*, 3 229–43 (*July–Sept.*, 1948).

Gauge transformations, leaving the formulation invariant, are developed and the transformations of the e.-m. and meson fields detailed. The special problem of the elimination of the longitudinal field is then considered. [See Abstr. 2960 (1949)].

G. J. KYNCH

530.145 : 538.3

1489. Interaction of electrons and an electromagnetic field treated by analytic continuation. S. B. NILSSON. *Ark. Fys.*, **1**, *Paper* 19, 369–422 (1949) *In English.*

The analytic continuation method ("α-method") for eliminating divergences has been found to be equivalent to the λ-limiting process in the classical theory of point charges, but to be more powerful in the quantum theory. The present paper contains an elaboration of the two forms in which the α-method has been introduced into quantum electrodynamics (by Gustavson and Pauli) and further discusses their interrelation and the connection with the classical theory of Riess and Fremberg and with the λ-process. The logarithmic divergences, which have so far been unaffected by the method, are now removed in the simplest cases (though not in the higher approximations); if the procedure is combined with Schwinger's method, the infinite mass-term that Schwinger isolates then becomes finite. A.

530.145 : 538.3

1490. The problem of vacuum polarisation. H. UMEZAWA AND E. YAMADA. Letter in *Progr. Theor. Phys.*, **3**, 456–8 (*Oct.–Dec.*, 1948).

Divergent terms due to vacuum polarization are examined for a mixture of many Dirac and scalar

fields, for elastic scattering or photon scattering, in order to find out under what circumstances they can be described entirely as renormalization terms.

G. J. KYNCH

530.145 : 539.152.1

1491. On the general formulation of meson pair theory. S. HJALMARS. *Ark. Fys.*, **1**, *Paper* 3, 41–116 (1949) *In English.*

A theory of generalized Dirac equations is applied to such particles as nucleons, scalar and vector mesons. One result is a convenient representation of the β-matrices in the matrix form of meson theory. Interaction terms are included and when specialized to apply to a meson pair theory the most general interaction is obtained between scalar or vector mesons pairs and nucleons in terms of the β and Dirac γ-matrices. After the elimination of the redundant components of the meson fields, these are expressed in the more usual form involving the space derivatives of the fields. It is also shown that a charge-conjugate formulation of the meson fields is possible. An appendix contains an alternative treatment of the interactions starting from a Lagrangian. G. J. KYNCH

530.145 : 539.152.1

1492. On the theory of nuclear forces. M. SUGAWARA. Letter in *Progr. Theor. Phys.*, **3**, 442 (*Oct.–Dec.*, 1948).

A vector meson theory with charged and neutral mesons of different masses (318 m and 159 m respectively) gives a very low value of the deuteron quadrupole moment, when arranged to remove the tensor force singularity in states of even parity.

G. J. KYNCH

530.145 : 539.18

1493. Reaction of radiation field on mesons. K. BABA AND S. KANESAWA. Letter in *Progr. Theor. Phys.*, **3**, 443–4 (*Oct.–Dec.*, 1948).

The renormalization technique of Tomonaga *et al.* cannot be applied directly to this problem owing to the occurrence of derivatives of the field quantities. The necessary subtractions can be made with a modified Lagrangian for the free meson field, and a correspondingly modified interaction term.

G. J. KYNCH

530.145 : 539.18

1494. The three quanta disintegration of the neutral meson. H. FUKUDA AND Y. MIYAMOTO. Letter in *Progr. Theor. Phys.*, **4**, 392–4 (*July–Sept.*, 1949).

The 3-quanta process is possible in 2nd order approx. only for vector and tensor couplings. The decay of scalar and pseudovector mesons with these couplings is also forbidden. Thus only the decay of a vector meson is calculated and the lifetimes are 5×10^{-5} and 4×10^{-3} sec for tensor and vector couplings respectively, for a meson of mass 300 m, using the covariant procedure together with the Pauli regularization process. Since these lifetimes are $\gg$ for disintegration into electron pairs it can be neglected. [Abstr. 1501 (1950)]. G. J. KYNCH

530.145 : 539.18

1495. On the γ-decay of the neutral meson. H. FUKUDA AND Y. MIYAMOTO. *Progr. Theor. Phys.*, **4**, 347–57 (*July–Sept.*, 1949).

Neutral mesons with scalar, pseudoscalar and pseudovector couplings can decay into two photons. The lifetimes of scalar and pseudoscalar mesons are calculated using the covariant theory, by a method due to Schwinger [Abstr. 6182 (1949)]. The result is not gauge-invariant, however, nor is it consistent with the equivalence of ps.-vector and ps.-scalar couplings or pseudoscalar theory. The decay of the pesudo-vector meson in this manner is not allowed.

G. J. KYNCH

530.145 : 539.18

1496. On the gauge difficulty in the γ-decay of the neutral scalar meson. D. ITO AND T. MIYAZIMA. Letter in *Progr. Theor. Phys.*, **4**, 380–1 (*July–Sept.*, 1949).

The lack of gauge invariance [Abstr. 1495 (1950)] in the answer of Miyamoto and Fukuda, can be removed if it is assumed that a decay is possible into intermediate states of a charged scalar field as well as of protons. G. J. KYNCH

530.145 : 539.18

1497. Application of Pauli's regulators to the γ-decay of neutrettos. H. FUKUDA, Y. MIYAMOTO, T. MIYAZIMA AND S. TOMONAGA. Letter in *Progr. Theor. Phys.*, **4**, 385–6 (*July–Sept.*, 1949).

When regularization is imposed one condition on the constants g for all fields of the type $\Sigma g = 0$ restores the equivalence of pseudoscalar and pseudovector couplings, and a second condition $\Sigma m^2 g = 0$ completes the restoration of gauge-invariance. It is not clear whether other regularization conditions should be imposed. If $\Sigma mg = 0$ in addition to the previous condition, another term is annihilated which greatly affects the lifetime. [Abstr. 1495–6 (1950)].

G. J. KYNCH

530.145 : 539.18

1498. On the C-meson theory. Y. KATAYAMA AND K. SAWADA. Letter in *Progr. Theor. Phys.*, **4**, 377–9 (*July–Sept.*, 1949).

The self-energy of the C-meson, which interacts with particles along with the electromagnetic field, has been calculated by methods which make the photon self-energy vanish. In contrast to the results of Umezawa and Yakada [Abstr. 1479 (1950)] the divergence is now only logarithmic. G. J. KYNCH

530.145 : 539.18

1499. On the electromagnetic self-energy of the meson. S. HANAWA AND S. KANESAWA. Letter in *Progr. Theor. Phys.*, **4**, 385 (*July–Sept.*, 1949).

An extra term in the self-energy is mentioned which was omitted earlier [Abstr. 1493 (1950)] arising from the elimination of the auxiliary equation. In the single-meson state, however, its expectation value is zero. G. J. KYNCH

530.145 : 539.18

1500. The half-life of radioactive decay of a free meson. N. SHÔNO AND H. HAGIHARA. Letter in *Progr. Theor. Phys.*, **4**, 363–6 (*July–Sept.*, 1949).

A calculation of the decay process $n \rightarrow p + \pi^-$, $\pi^- + \nu \rightarrow e$ gives an answer which is difficult to reconcile with the necessary time for a π^- meson to decay to an electron, whatever mass is used for the π-meson, provided it has spin 1. G. J. KYNCH

530.145 : 539.18

1501. On the electron-positron pair disintegration. H. FUKUDA AND Y. MIYAMOTO. Letter in *Progr. Theor. Phys.*, **4**, 391–2 (*July–Sept.*, 1949).

The decay of a neutral meson in this way is only possible for a vector meson, in 2nd order. To remove divergences which remain after a covariant calculation the Pauli regularization method can be applied. The meson lifetime is then 10^{-14} or 10^{-11} sec, according as tensor or vector coupling is used. Alternatively the constants for these two types of coupling can be so chosen that the divergences cancel. A lifetime of 10^{-10} sec is then found. [See Abstr. 1494, 1497 (1950)]. G. J. KYNCH

530.145 : 539.185

1502. On the mesic self-field around a nucleon. K. NAKABAYASI. *Progr. Theor. Phys.*, **2**, 163–78 (*Nov.–Dec.*, 1947).

The self-field is investigated for a symmetric longitudinal vector meson field in semi-classical theory with an isotopic spin vector, using a subtraction procedure similar to that of Pryce [Abstr. 1978 (1938)]. For the symmetric theory no excited states of the nucleon exist for small coupling, but this is not true in a charged theory. For strong coupling more than one isobar may exist and be stable. G. J. KYNCH

530.145 : 539.185

1503. Magnetic interaction between neutrons and electrons. H. EKSTEIN. *Phys. Rev.*, **76**, 1328–31 (*Nov.* 1, 1949).

The phenomenological interaction operator between neutrons and electrons is usually assumed to be $-\mu\mathbf{s}\,.\,\mathbf{B}$. ($\mu\mathbf{s}$ magnetic moment of the neutron, $\mathbf{B}$ magnetic field of the electrons.) Bloch has pointed out [*ibid.*, **51**, 994 (1937)] that other operators are possible. It is shown that the class of operators considered by Bloch is equivalent with the form $-\mu\mathbf{s}\,.\,(\mathbf{H} + 4\pi C\mathbf{M})$ where $\mathbf{M}$ is the spin momentum density of the electrons, $\mathbf{H} = \mathbf{B} - 4\pi\mathbf{M}$ and C is an indeterminate constant. Diffraction by ferromagnetic crystals and magnetic double refraction are calculated for this interaction. Present experimental evidence excludes the value $C = 0$. Experimental methods for measuring C are discussed. A.

530.145 : 537.122

1504. On the exchange effects between electron and positron. V. B. BERESTETSKIĬ AND L. D. LANDAU. *J. Exp. Theor. Phys., USSR*, **19** (*No.* 8) 673–9 (1949) *In Russian.*

A wavefunction allowing for exchange is required for the electron-positron system accurate to terms in v^2/c^2 (v velocity of charge). It is necessary to find matrix elements $V_{ns}^{n's'}$, corresponding to a transition of an electron from state n to n' simultaneous with a transition of a second electron from s to s'. A state of positive and all states but one of negative energy are filled so that only $V_{n-s'}^{n'-s}$, $V_{n-s'}^{-sn'}$ matter. The Hamiltonian for the electron system is used from the method of repeated quantization. The wavefunction of an electron with negative energy is replaced by a positron wavefunction. The expression for the exchange energy is of order $\hbar/mc$, hence its terms containing the δ function can be treated as perturbation on Coulomb exchange effects. J. JACOBS

530.145

1505. On the Dirac's indefinite metric spac N. SHÔNO AND N. ODA. *Progr. Theor. Phys.*, 358–63 (*July–Sept.*, 1949).

530.145

1506. A new formulation of the variational princip for scattering problems. S. S. HUANG. Letter *Phys. Rev.*, **76**, 866–7 (*Sept.* 15, 1949).

A method is given which aims at simplicity f practical applications, and to combine the merits the methods by Hulthén [Abstr. 491 (1945)] ar Tamm [Abstr. 2983 (1949)], without their di advantages (i.e. without a complicated process successive numerical approximations, and witho restriction by the use of a very special trial wav function). A. BEE

530.145

1507. The exchange energy of relativistic particle in second approximation with respect to charge ZH. S. TAKIBAEV. *J. Exp. Theor. Phys., USSR*, **1** (*No.* 8) 680–7 (1949) *In Russian.*

A system of 2 particles with exchange is investi gated in limits of classical electrodynamics. Th exchange energy appears as an expansion in power of the charges; a formula is derived for that part o the exchange energy which is $\propto$ the charge produc of the two particles, analogous to Moeller's quantum theoretical formula. By use of a different time system for each particle a complete series is obtained sym metrical in co-ordinates and velocities of both particles Exchange effects lead to terms in velocity calculation of order $> e^2$, hence in this approximation tha particles can be treated as free. The same problem is investigated by the Hamilton–Jacobi method using classical perturbation theory. J. JACOBS

530.145.6

1508. The use of quaternions in wave-tensor calculus. C. W. KILMISTER. *Proc. Roy. Soc. A*, 517–32 (*Dec.* 7, 1949).

Quaternions are used to obtain some of Edding ton's results in a general affine space, and a more convenient notation for E-numbers is suggested. As an example, Dirac's equations are derived, their connection with the affine space of distant parallelism is explained, and Eddington's views on their "Euclidean" nature are discussed. A.

530.145.6

1509. The wave equations of particles with spin $\hbar/4\pi$ and their solutions in general nuclear fields. G. PETIAU. *J. Phys. Radium* (*Sér.* 8) **10**, 264–76 (*Oct.*, 1949) *In French.*

The fields considered are of the type (more general than the electromagnetic field) arising in modern nuclear theory. An earlier non-relativistic treatment [*C.R. Acad. Sci., Paris*, **227**, 263–4 (*July* 26, 1948)] is extended, and the relativistic problem is considered for the case of radial interactions, with special reference to some important particular cases in which the energy levels and special functions may be calculated. P. M. DAVIDSON

530.145.6

1510. Physical solutions of the equation of the point electron. A. LOINGER. *Nuovo Cim.*, **6**, 360–7 (*Sept.*, 1949) *In Italian.*

The meaning of a criterion given by Caldirola [Abstr. 1695 (1949)] in order to select the physical solution of Dirac's equations of the electron motion is discussed. Applications of such a criterion are made to several problems. A.

530.145.6 : 537.122

1511. Quantum electrodynamics. III. The electromagnetic properties of the electron—radiative corrections to scattering. J. SCHWINGER. *Phys. Rev.*, **76**, 790–817 (*Sept.* 15, 1949).

[See Abstr. 3764, 6751 (1949)]. The discussion of vacuum polarization in the previous paper of the series was confined to that produced by the field of a prescribed current distribution. The induction of current in the vacuum by an electron is now considered. The additional current attributed to an electron implies an alteration in its electromagnetic properties which will be revealed by scattering in a Coulomb field and by energy level displacements. This paper is concerned with the computation of the second-order corrections to the current operator and the application to electron scattering. Following a canonical transformation which effectively renormalizes the electron mass, the correction to the current operator produced by the coupling with the electromagnetic field is developed in a power series, of which first- and second-order terms are retained. One thus obtains second-order modifications in the current operator which are of the same general nature as the previously treated vacuum polarization current, save for a contribution that has the form of a dipole current. The latter implies a fractional increase of $\alpha/2\pi$ in the spin magnetic moment of the electron. The only flaw in the second-order current correction is a logarithmic divergence attributable to an infrared catastrophe. It is remarked that, in the presence of an external field, the first-order current correction will introduce a compensating divergence. Thus, the second-order corrections to particle electromagnetic properties cannot be completely stated without regard for the manner of exhibiting them by an external field. Accordingly, one considers in the second section the interaction of 3 systems, the matter field, the electromagnetic field, and a given current distribution. It is shown that this situation can be described in terms of an external potential coupled to the current operator, as modified by the interaction with the vacuum electromagnetic field. Application is made to the scattering of an electron by an external field, in which the latter is regarded as a small perturbation. It is found convenient to calculate the total rate at which collisions occur and then identify the cross-sections for individual events. The correction to the cross-section for radiationless scattering is determined by the second-order correction to the current operator, while scattering that is accompanied by single quantum emission is a consequence of the first-order current correction. The final object of calculation is the differential cross-section for scattering through a given angle with a prescribed max. energy loss, which is completely free of divergences. Detailed evaluations are given in 2 situations, the essentially elastic scattering of an electron, in which only a small fraction of the kinetic energy is radiated, and the scattering of a slowly moving electron with unrestricted energy loss. The Appendix is devoted to an alternative treatment of the polarization of the vacuum by an external field. The conditions imposed on the induced current by the charge conservation and gauge invariance requirements are examined. It is found that the fulfilment of these formal properties requires the vanishing of an integral that is not absolutely convergent, but naturally vanishes for reasons of symmetry. This null integral is then used to simplify the expression for the induced current in such a manner that direct calculation yields a gauge invariant result. The induced current contains a logarithmically divergent multiple of the external current, which implies that a non-vanishing total charge, ∞ the external charge, is induced in the vacuum. The apparent contradiction with charge conservation is resolved by showing that a compensating charge escapes to infinity. Finally, the expression for the electromagnetic mass of the electron is treated. A.

530.145.6 : 538.3

1512. On the energy of the meson interaction between particles. J.-G. VALATIN. *C.R. Acad. Sci., Paris*, **228**, 1573–5 (*May* 16, 1949) *In French.*

The method of obtaining interaction terms previously given [Abstr. 6761 (1949)] is here applied to meson theory. The resulting expression is again split into longitudinal and transverse parts for mesons of spin 1. G. J. KYNCH

530.145.6 : 539.18

1513. Interaction between elementary particles. I. A. LANDÉ. *Phys. Rev.*, **76**, 1176–8 (*Oct.* 15, 1949).

An elementary particle is considered as a mathematical point which under an invariant law of communication involving a universal length a establishes a primary potential in space-time. Due to the peculiar communication law, $r^2 - c^2t^2 + a^2 = 0$ or $S^2 = 0$, in contrast to the light signal law $R^2 = 0$, the primary potential is without singularity at $r = 0$. It becomes the background of a regular electrodynamic or mesonic field and automatically yields a finite radius a to the charge distribution, with a density falling off as $(a/r)^5$ at larger distances. The potentials of different particles are additive so that all quantities obey the superposition law. The total force on the Nth particle is produced under the same invariant communication law $S = 0$ by integration of the force density k_N over the volume elements of the instantaneous rest system. K_N is the resultant of mutual and self-forces, $K_N = S_M K_{MN}$. Only retarded field interaction is admitted between different particles. The original production of the self-charge by the centre and its force reaction on the centre is derived from a heuristic scheme involving half-retarded, half-advanced potentials, as a substitute for the instantaneous reaction between the "parts" of a charge. In the dynamics of the particle a variable "acceleration mass" of field origin is added to the mechanical mass. An experimental determination of mass differences under various very high accelerations could reveal

the unknown ratio between the field mass and the mechanical mass of a charged particle. A.

530.145.6 : 539.18

1514. On the electromagnetic properties of nucleons. S. Borowitz and W. Kohn. *Phys. Rev.*, **76**, 818–27 (*Sept.* 15, 1949).

The methods recently developed by Schwinger [Abstr. 3764, 6751 (1949)] for dealing with problems in quantum electrodynamics have been applied to an investigation of the electromagnetic properties of nucleons in interaction with pseudoscalar mesons. The calculated values of the magnetic moments of the neutron and proton are in agreement with results recently obtained by Case, Luttinger, and Slotnick and Heitler using different calculational procedures. The result for the neutron-electron interaction is identical with that obtained by Case. Included in the paper are the anomalous proton-electron interaction and a qualitative discussion of the scattering of high energy nucleons. The large coupling constants necessary to fit any of the experimental data show that the results obtained by a second order perturbation calculation are not quantitatively reliable. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.15 : 533.2

1515. An extension of Hamy's theorem to rotating gaseous bodies. N. L. Ghosh. *Bull. Calcutta Math. Soc.*, **41**, 92–102 (*June*, 1949).

Previous work [Abstr. 5983 (1949)] is extended. It is proved that a heterogeneous mass of gas in which the pressure is a function of the density, rotating under its own gravitation, cannot attain a similar-ellipsoidal density-distribution. L. S. GODDARD

531.19 : 530.145

A general theorem of the transitional probabilities of a quantum mechanical system with spatial degeneracy. *See Abstr.* 1482

531.224.8 : 621–272

1516. On highly compressible helical springs and rubber rods, and their application for vibration-free mountings. V. J. A. Haringx. *Philips Res. Rep.*, **4**, 375–400 (*Oct.*, 1949).

[See Abstr. 1706 (1949)]. Deals with the behaviour in space of the different types of vibration-free mounting, starting from the simple construction of a resiliently supported body up to the damped dynamic vibration absorber provided with an auxiliary mass. To simplify the problems of forced and free vibrations an attempt is made to split up the movements in space into a number of one- and two-dimensional movements to be treated independently. A.

531.45

1517. Effect of surface roughness on rolling friction. J. J. Bikerman. *J. Appl. Phys.*, **20**, 971–5 (*Oct.*, 1949).

531.51

1518. On a physical theory of gravitation. Z. Nubar. **A remark on the subject of the preceding note.** J. Chazy. *C.R. Acad. Sci., Paris*, **229**, 743–5 (*Oct.* 1949) *In French.*

Gravitation is supposed to arise from the collisio of particles filling space. The theory, which adds force ∝ the inverse distance to Newtonian attractio is applied to planetary motion. R. A. NEWI

531.

1519. Inertia and gravity of matter. P. Selén *Hungar. Acta Phys.*, **1** (*No.* 5) 7–11 (1949) *English.*

A simple verification of the equality of gravitation and inertial mass is provided by the observation th a body, floating in liquid on the surface of a rotati earth, would not be in equilibrium if the gravitation constant depended on the constitution of matter. R. A. NEWI

MECHANICAL MEASUREMENTS 531.7

531.719 : 534.231

1520. Acoustic impedance of ring-shaped sli (A new method of measuring small displacements H. Itokawa. *J. Soc. Appl. Mech. Japan*, **2** (*No.* 1 23–4 (1949) *In Japanese.*

Theory and experimental results are given of method of measuring small displacements to 1 accuracy by the change in acoustic impedance of ring-shaped slit. A

531.724 : 541.18

1521. Simplified technique for surface area determina tion by adsorption of nitrogen. W. V. Loebenstei and V. R. Deitz. *J. Chem. Phys.*, **17**, 1004–5 (*Oct* 1949).

The method proposed is based on the Brunauer Emmet and Teller procedure but does not requir any vacuum pumping equipment. One arm of the U-shaped adsorption tube contains the sample and the other arm is a capillary tube. Each arm is con nected to a calibrated gas burette with attached Hg levelling bulbs. After freeing the sample from ai and moisture by heating, the "dead-space" volume is found by using He gas in the tube and surrounding the sample with liquid O. A measured quantity of N is introduced and by means of the levelling bulbs is made to pass to and fro over the sample until constant pressure is obtained. The pressure of He has little effect on the adsorption. Results for a variety of samples agree well with those obtained with a con ventional apparatus. J. IBALL

531.732

1522. Volume dilatometry. N. Bekkedahl. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 145–56 (*Aug.*, 1949).

The preparation and operation of the volume dilatometer are described in detail. An illustrative calculation is given using data obtained from volume-temp. measurements on a sample of butyl rubber from about −30° to +90°C, using Hg as a confining liquid in the dilatometer. A.

MECHANICS OF FLUIDS 532

532.1

1523. Equipment for compressibility measurements. Data on propane. B. J. CHERNEY, H. MARCHMAN AND R. YORK, JR. *Industr. Engng Chem.*, **41**, 2653–8 (*Nov.*, 1949).

Equipment is described for measuring pressure-volume-temperature characteristics of fluids from room temp. to 300°C and from 10 to 220 atm. The apparatus is suitable for measuring vapour pressures and critical properties as well as compressibilities. The limit of accuracy is estimated to be 0·25%. This has been verified by measurements on propane, some new data on which are reported. A.

532.13

1524. Two model laws on highly viscous fluids. A. H. M. ANDREASEN. *J. Soc. Glass Tech.*, **33**, 163–6(*T*) (*June*, 1949).

Simple formulae are given to cover cases in which, besides viscosity, only either gravitational or surface forces need be considered. R. O. DAVIES

532.13

1525. Mixture law for viscosity. L. GRUNBERG AND A. H. NISSAN. *Nature, Lond.*, **164**, 799–800 (*Nov.* 5, 1949).

532.133

1526. Effect of shape and interaction on the viscosity of dilute solutions of large molecules. R. SIMHA. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948, *Pt II*, 68 (1949).

532.133 : 541.182.6

Viscometry of settling suspensions with a rotational viscometer. *See Abstr.* 2059

532.133 : 541.182.6 : 537.226.2

1527. Viscosity and dielectric constant of liquid dispersions and solutions. A. VOET. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948, *Pt II*, 15 (1949).

For the dielectric constant ε of a dispersion of particles in volume fraction V in a medium of dielectric constant ε_2, the following approximate equation is used: $\varepsilon = \varepsilon_2(1 + 3fV)$, where f is a form factor indicative of the deviation of the particle shape from spherical form. For the state of rest a marked increase in dielectric constant is noted, explicable only on the assumption of particle agglomeration. Dispersions for which the agglomeration factor $= 1$ show Newtonian flow, those for which the factor is > 1 are non-Newtonian. The variation of the agglomeration factor with time once shearing stress is removed enables one to follow the process of rebuilding the particle structure, which may take many minutes. Evidence is adduced to show that in polymer solutions the polymer particles move independently at lower concentrations. Above a critical concentration the particles no longer move independently, though shearing stresses can break up most of the agglomerates. The higher the molecular weight of the polymer, the lower the critical concentration and the more pronounced the particle interaction.

BRITISH RHEOLOGISTS' CLUB

532.133 : 541.64

1528. The viscosity of concentrated solutions of polymers. H. DE BRUIJN. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948, *Pt II*, 95 (1949).

Two forms of mechanical interaction between the particles are distinguished: a long-distance "hydrodynamic interaction," and a "mechanical interaction by contact." An empirical relation covers both forms when small spherical particles are concerned. In more concentrated polymer solutions the radius of the spherical coils will change and the "rheologically effective radius" will become smaller in more concentrated solutions. A relation connecting the intrinsic and actual viscosities of polymer solutions at different concentrations is derived.

BRITISH RHEOLOGISTS' CLUB

532.133 : 541.64

1529. Viscosity of dilute macromolecular solutions. C. SADRON. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948, *Pt I*, 62 (1949).

532.14

1530. Density of water as a function of temperature. G. ANTONOFF AND R. J. CONAN. *Z. Naturforsch.*, **4a**, 156 (*May*, 1949) *In English.*

See Abstr. 6157 (1949).

532.5 : 536.24 : 518.5

Application of electric-analog computers to heat-transfer and fluid-flow problems. *See Abstr.* 1381

532.517

1531. Critical Reynolds' numbers of solutions of large molecules. R. SCHNURMANN. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948, *Pt II*, 142 (1949).

532.517 : 541.64

1532. Hydrodynamic properties of randomly coiled long chain molecules as determined by experiments on large scale models. H. KUHN. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948, *Pt II*, 44 (1949).

532.517 : 541.64

1533. Some observations on the flow of linear polymer solutions through straight tubes at large Reynolds numbers. B. A. TOMS. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948, *Pt II*, 135 (1949).

532.517 : 541.64

1534. Some flow properties of solutions of polymers. C. N. DAVIES. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948, *Pt II*, 152 (1949).

532.521

1535. The viscosity anomaly causing the spinning of liquids. Stress–flow curves of liquid threads. H. NITSCHMANN. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948, *Pt II*, 32 (1949).

532.517.4

1536. A suggested method of detecting wall-effects in turbulent flow through tubes. J. G. OLDROYD. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948, *Pt II*, 130 (1949).

Certain results by Toms on the high rates of flow of polymer solutions are explained on the hypothesis that a turbulent regime exists with a wall-effect akin to the σ-phenomenon. The Reynolds number is calculated on the basis of taking the viscosity at the highest rate of shear—i.e. at the wall—to characterize the viscosity of the fluid. It is suggested that one effect of the slip at the wall is to produce, sometimes,

conditions where the addition of a solute results in an increased rate of flow for standard pressure gradients. This phenomenon has been observed by Toms.

BRITISH RHEOLOGISTS' CLUB

532.517.4

1537. The transformation between one- and three-dimensional power spectra for an isotropic scalar fluctuation field. L. S. G. KOVASZNAY, M. S. UBEROI AND S. CORRSIN. Letter in *Phys. Rev.*, **76**, 1263–4 (*Oct.* 15, 1949).

This note draws attention to a mathematically simple result bearing on the relative behaviours of vector and scalar quantities in the turbulent flow of an incompressible medium. P. M. DAVIDSON

532.517.4

1538. Onset of turbulent flow in certain arrays of particles. J. W. FOX. *Proc. Phys. Soc. B*, **62**, 829–32 (*Dec.*, 1949).

Reynolds' number has been found for the onset of turbulence in water flowing through a perfectly packed hexagonal array of uniform spheres. Experiments have also been carried out on an imperfectly packed array of the same spheres and on an array of irregular particles (marble chips). A satisfactory differential manometer, which enables differences of head of the order of 0·01 mm of water to be readily determined, is described. A.

532.52 : 536.25

1539. Convection currents in porous media. II. Observation of conditions at onset of convection. H. L. MORRISON, F. T. ROGERS, JR. AND C. W. HORTON. *J. Appl. Phys.*, **20**, 1027–30 (*Nov.*, 1949).

Small-scale experiments have been carried out for determining the min. vertical thermal gradient which is required to cause convection in liquids entrapped in porous media. Observations relative to the onset of convective flow in unconsolidated sands indicate that the present theories predict min. gradients which are excessive by considerable amounts, possibly because they neglect the temp.-dependence of viscosity. A.

532.525

1540. An improved spinning top homogeneous spray apparatus. K. R. MAY. *J. Appl. Phys.*, **20**, 932–8 (*Oct.*, 1949).

An apparatus is described which produces homogeneous mists or clouds of solid particles of any desired size. Liquid is sprayed by a Beams high-speed air-driven top, using a property of high-speed air films so that automatic extraction of unwanted satellite droplets, better running characteristics over a wider range, simplified construction and low air consumption are obtained. A.

532.527

1541. The flow under gravity of a swirling liquid through an orifice-plate. A. M. BINNIE AND J. F. DAVIDSON. *Proc. Roy. Soc. A*, 443–57 (*Dec.* 7, 1949).

An examination has been made of the whirlpool formed when a perfect liquid possessing swirl passes under gravity through a circular sharp-edged hole in the base of a large tank. Relaxation methods were applied to determine the velocity distribution in the liquid and the shapes of the air-core and of the initial part of the emergent jet. In the numerical case considered, the swirl was large; and it was found that except close to the orifice, the radial and vertical velocities were too small to influence the shape of the air-core within the tank. Below the orifice the liquid was emitted as a conical and rapidly thinning jet. In spite of the contraction at the edge of the hole, the discharge was not greatly different from that determined by Binnie and Hookings' [Abstr. 273 (1948)] approximate method for flow through a trumpet. Experiments with water were made for comparison with the calculations. It was noticed that under certain conditions of low swirl the annular jet assumed a cylindrical vibrating form. The theory of these oscillations, which was confirmed by observation, shows that, unless the air-core occupies a large fraction of the cross-section of the jet, the wavelength is nearly the same as that in a "solid" jet of the same outer diameter.

532.52

1542. Experiments on flow with cavitation in water mixed with air. R. E. H. RASMUSSEN. *Trans. Danish Acad. Tech. Sci.* (*No.* 1) 3–60 (1949) *In English.*

Air bubbles introduced into the water passing a ship's propellers have the effect of reducing the noise. To find what other effects the bubbles may have in this and similar cases, extensive experiments were made with solid bodies in motion relative to water; the effects of air bubbles on the pressure distribution, cavitation and erosion were studied. P. M. DAVIDSON

532.543

1543. Calculations on the flow of heterogeneous mixtures through porous media. H. C. BRINKMAN. *Appl. Sci. Res.*, **A1** (*Nos* 5–6) 333–46 (1949).

Muskat and Meres [*Physics*, **7**, 346 (1936)] have formulated basic differential equations governing the motion of heterogeneous fluid mixtures through porous media. They obtained a solution of these equations by numerical integration for the problem of a column initially filled with liquid saturated with gas, which is closed at one end and kept at a constant low pressure at the other. Buckley and Leverett [*Trans. AIME*, **146**, 107 (1942)] obtained an analytical solution for the problem of a column initially filled with liquid which is flooded with a second immiscible liquid. They found a solution in which the saturation is a 3-valued function of the co-ordinate along the column. A discussion is given of Buckley and Leverett's solution. It appeared that the true solution which contains a discontinuity may be derived from the 3-valued solution by a discussion of the integral relation which represents the total liquid recovery from the column. This discussion bears a formal resemblance to that occurring in the theory of van der Waals' equation of state. The second problem treated is that of a vertical column initially filled with liquid saturated with gas under a high pressure, which is opened at its lower end. For this problem an analytical solution for low values of the pressure gradient is obtained. Here again the paradox of a 3-valued solution occurred and led to a discontinuity in the saturation. A general argument is given to the effect that 3-valued solutions are unavoidable for a theoretical treatment based on Muskat's equations of problems which lead to discontinuities in the saturation. A.

532.582.7 : 541.64

1544. The shape of macromolecules in solution and the interrelationships of their hydrodynamic parameters. S. NEWMAN, J. RISEMAN AND F. EIRICH. *Rec. Trav. Chim. Pays-Bas*, **68**, 921–38 (*Nov.*, 1949) *In English.*

CAPILLARITY 532.6

532.6

1545. Rate of growth of mercury drops forming at the end of a capillary. G. S. SMITH. Letter in *Nature, Lond.*, **164**, 664–5 (*Oct.* 15, 1949).

Results for the drop-time and rate of flow of drops, formed under a constant 60 cm head of Hg, at the end of a capillary immersed in 0·1 N KCl at 23°C, when free, and when constrained by flicking the capillary so that the drops break off after $\sim \frac{1}{3}$ of their normal lifetime, are given. These show the volume of a drop is closely $\propto$ its age. The rate of flow for continuous delivery of Hg was also determined. It is concluded that the volume of a drop formed under various conditions equals that flowing in the same time under steady flow through the capillary, and that the surface area of a drop is $\propto$ the $\frac{2}{3}$ power of the time. S. WEINTROUB

532.61

1546. Surface polarization and wettability of inorganic substances by water. D. P. ENRIGHT, L. R. SONDERS AND W. A. WEYL. Letter in *J. Appl. Phys.*, **20**, 1011–12 (*Oct.*, 1949).

Contact angle hysteresis has never been completely explained and this is especially so in connection with the difference between the advancing and receding contact angles of water on the surface of inorganic substances. The authors record observations which indicate that in the latter an explanation may be found in the variability of the surface polarization of inorganic ions, e.g. Montmorillonite clays containing respectively Na^+, Ca^{2+} and Pb^{2+} ions were found to show decreasing initial wettability by water in this order. Surface roughness and possible contamination were identical. It is suggested that this is due to the fact that the polarizability of the ions increases in the order Na^+, Ca^{2+}, Pb^{2+}, thus the force fields extending into the gas phase become progressively weaker from Na^+ to Pb^{2+}. After the surface has been in contact with water for some time contrapolarization will reduce the asymmetry of the interfacial force fields and wettability will increase. [See Abstr. 5838 (1949)]. J. IBALL

532.612.4

1547. Surface tension of molten zinc borates. L. SHARTSIS AND R. CANGA. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 221–6 (*Sept.*, 1949).

The surface tension of melts in the system ZnO–B_2O_3, ranging from 0 to 79·5% of ZnO, were measured with a maximum pull-on-cylinder method. In the 2-liquid region, which extends from approximately 0 to 53% of ZnO, the value of surface tension was that of B_2O_3 within the limits of experimental error. With percentages of ZnO beyond the 2-liquid region, the surface tension value increased rapidly. Melts containing approx. 55 to 65% of ZnO showed minima in the curves of surface tension *v.* temp. Melts containing approx. 65 to 75% of ZnO had positive temp. coeffs. of surface tension. The melt containing 79·5% of ZnO had a negative temp. coeff. The densities at room temp. were also measured. A.

532.62

1548. Application of a general theory of the formation of liquid films to solutions of lanthanum chloride. L. B. ROBINSON. *J. Chem. Phys.*, **17**, 960–4 (*Oct.*, 1949).

The hyperelliptic integrals involved are approximated with elliptic integrals. The small values of the zeta-potentials make reliable assignments of the values of the "corrected surface tensions" difficult. A.

532.62

1549. Some properties of the energy of activation of viscous flow of monomolecular layers and their structural interpretation. M. JOLY. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948, *Pt II*, 35 (1949).

The viscosity of monomolecular layers may be measured by adapting existing methods to two-dimensional systems. The method of capillary flow gives very precise results, even with very fluid layers. There is no slipping between the layer and its support, but the viscosity of the support in the immediate neighbourhood of the interface has been up to the present in doubt. The author has derived equations governing the laminar flow of a monomolecular layer in a canal; this cannot be integrated exactly, but an approximate solution is well supported experimentally. BRITISH RHEOLOGISTS' CLUB

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

1550. The kinetic theory of liquids of M. Born and H. S. Green. E. ARNOUS AND D. MASSIGNON. *J. Phys. Radium*, **10**, 45–55D (*July–Aug.–Sept.*, 1949) *In French.*

A short account of the theory [Abstr. 771, 1147, 2792, 3435 (1947), 2375 (1948)], including a bibliography. H. LONDON

532.7 : 536.71 : 531.19

1551. The equation of state in quantized kinetic theory and quantum statistical mechanics. H. S. GREEN. *Physica*, **15**, 882–90 (*Oct.*, 1949).

A rigorous derivation is given of the equation of state of a fluid on the basis of quantum statistical mechanics, and it is confirmed that the thermodynamic pressure so obtained differs from the kinetic pressure derived from quantum hydrodynamics or otherwise. The difference is evaluated and it is shown that it becomes appreciable at very low temps. A.

532.7 : 536.71 : 531.19

1552. The caloric and thermal equation of state in quantum statistical mechanics. J. DE BOER. *Physica*, **15**, 843–8 (*Oct.*, 1949).

It is shown that in classical as well as in quantum mechanics the "dynamic" expressions for the caloric

and thermal equations of state obtained with the method of quantum statistical mechanics are identical with the expressions obtained by the partition function method of statistical thermodynamics. A.

532.7 : 537.531 : 535.42

1553. X-ray diffraction in liquid sulfur. J. A. PRINS AND N. J. POULIS. *Physica*, **15**, 696–706 (*Sept.*, 1949).

Inside the principal halo with Bragg spacing 3·6 Å a new ring with spacing 5·6 Å was found. Neither ring changes with temp. up to 230°C. A description of the experimental arrangement in this and in some previous investigations is given. It is pointed out that the usual picture of S_8-rings transforming to long chains at 160° is still rather speculative. A.

532.71

1554. The kinetics of membrane processes. I. The mechanism and the kinetic laws for diffusion through membranes. K. J. LAIDLER AND K. E. SHULER. *J. Chem. Phys.*, **17**, 851–5 (*Oct.*, 1949).

The equations for diffusion in binary systems are extended to the case of diffusion through a membrane. 3 elementary rate processes are considered at a solution-membrane interface: (1) adsorption of the diffusing species, (2) desorption back into the solution, and (3) diffusion into the membrane, and an expression for the rate constant of the overall process of surface penetration is developed in terms of 3 specific rate constants. Various special cases are considered and discussed with reference to the experimental data. A general expression for the rate of diffusion of a species through a membrane under steady-state conditions is derived, the rate being expressed as a function of activities. It is shown that the application of this expression to the case of a solvent passing through a membrane which is impermeable to the solute leads to the thermodynamically exact equation for the osmotic pressure. Expressions are given for the rate of flow of solvent and solute through a membrane as a function of the osmotic and hydrostatic pressures across the membrane. A.

532.71.

1555. The kinetics of membrane processes. II. Theoretical pressure-time relationships for permeable membranes. K. J. LAIDLER AND K. E. SHULER. *J. Chem. Soc.*, **17**, 856–60 (*Oct.*, 1949).

The rate equations developed in Part I for the flow of solvent and solute through a permeable membrane have been extended to the case in which the flow is measured by the rise and fall in a capillary inserted into the more concentrated solution. The differential equation obtained for this case has been integrated to give an explicit relationship between the height of rise in the capillary and the time. The equation is shown to give the height-time relationship in the form found by experiment. It is shown that the osmotic pressure obtained with a semi-permeable membrane is a special case of the more general theory of diffusion through membranes permeable to both solvent and solute. The possibility of positive and negative values of P, i.e. of initial rise or fall respectively in the capillary, is discussed, and the significance of these cases evaluated in terms of the molar volumes and permeation constants of solvent and solute. A.

532.

1556. The kinetics of membrane processes. III. Th diffusion of various non-electrolytes through collodi membranes. K. E. SHULER, C. A. DAMES and K. LAIDLER. *J. Chem. Phys.*, **17**, 860–5 (*Oct.*, 1949).

Measurements have been made of the rates diffusion of various non-electrolytes, and of wate through a collodion membrane separating a dilu solution from pure water. The determinations we made by measuring the rate of rise and fall in capillary tube in the solution, and analysing the resul using the procedure described in a previous pape The work was done with 0·25 N solutions of sucros lactose, raffinose and mannitol, and was carried o at different temps. so that energies and entropi of activation could be determined. The energy activation for diffusion through the membranes wa found in all cases to be slightly < for free diffusio a result that is shown to be consistent with a positiv heat of adsorption of the solute and solvent at th membrane. Analogously the entropies of activatio for membrane diffusion are somewhat < for fre diffusion, since the process of adsorption brings abou a decrease in entropy. The rate of diffusion of wate through a membrane is shown to depend upon th nature of the solute diffusing, a result which aris from the fact that diffusion is a mutual process. A experiment is described in which there is an initia net flow from the solution into the solvent. A

532.7

1557. A preliminary study of the permeability c cellophane to liquids. S. MADRAS, R. L. MCINTOS AND S. G. MASON. *Canad. J. Res. B*, **27**, 764–7 (*Sept.*, 1949).

532.7

1558. Diffusion in binary liquid hydrocarbon mix tures. D. J. TREVOY AND H. G. DRICKAMER *J. Chem. Phys.*, **17**, 1117–20 (*Nov.*, 1949).

Diffusion coeffs. have been obtained for binary mixtures of paraffin hydrocarbons and for mixture of paraffin hydrocarbons with benzene using a diaphragm cell. The results have been tested by th equations of Arnold, of Stokes and Einstein, and o Stearn, Irish and Eyring. Of these only the semi empirical relationship of Arnold gives satisfactory agreement with experiment. A

532.72

1559. Thermal diffusion in binary liquid hydrocarbon mixtures. D. J. TREVOY AHD H. G. DRICKAMER *J. Chem. Phys.*, **17**, 1120–4 (*Nov.*, 1949).

Thermal diffusion coeffs. have been measured fo a series of binary mixtures of paraffin hydrocarbons and of paraffin hydrocarbons with benzene. The temp.-dependence of the coeff. is shown to be small. The results are correlated quite satisfactorily by assuming that the mobility of a molecule is inversely $\propto$ the product of the molecular mass and molecular cross-section in the direction of flow. A.

532.74

1560. The tensile strengths of liquids. I. Thermodynamic considerations. S. W. BENSON AND E. GERJUOY. *J. Chem. Phys.*, **17**, 914–18 (*Oct.*, 1949).

An investigation is made of the thermodynamic stability of liquids under tension. Comparisons o the Helmholtz free energies show that small sample

of liquid under tension are unstable with respect to 2-phase liquid-vapour equilibrium at the same volume and temp. Defining the tensile strength as the negative pressure at which $(\partial P/\partial V)_T = 0$ for the liquid, it is possible to calculate "maximum" possible tensile strengths from equations of state. The van der Waals and Berthelot equations in reduced form can be adapted to such explicit calculation and give values much lower, and therefore much closer to experimental values, than previous calculations. For non-associated liquids at 27°C, the van der Waals max. tensile strengths are about 150 atmos., whereas the Berthelot values are about 750 atmos. The temp. dependence for the two equations is about 1 and 6 atmos. °C, respectively. Comparisons with observation of the calculated reduced liquid volume, energy of vaporization, coeff. of thermal expansion and bulk compressibility support the use of the van der Waals and Berthelot equations in computing liquid properties. A.

532.74 : 531.19

1561. The statistical mechanical theory of transport processes. III. The coefficients of shear and bulk viscosity of liquids. J. G. KIRKWOOD, F. P. BUFF AND M. S. GREEN. *J. Chem. Phys.* **17**, 988–95 (*Oct.*, 1949).

A molecular theory of the coeffs. of shear and bulk viscosity of monatomic liquids is developed on the basis of the general theory of transport processes presented in the first article of this series [Abstr. 2043 (1946)]. With the use of the Lennard–Jones potential and a reasonable analytic approximation to the experimental radial distribution function, calculations of the coefficients of shear and bulk viscosity of liquid A at 89°K have been carried out. The theory leads explicitly to ratios of the coeffs. to the friction constant of the theory of Brownian motion. With a preliminary estimate of the friction constant, a value of the shear viscosity of liquid argon in moderately good agreement with experiment is obtained. A.

MECHANICS OF GASES 533

533.15

1562. Self-diffusion in argon. F. HUTCHINSON. *J. Chem. Phys.*, **17**, 1081–6 (*Nov.*, 1949).

The self-diffusion coeff. of argon was measured at 5 different temps. between −183°C and 53·5°C by observing the diffusion of radioactive A^{41} into normal A. The decrease in the observed diffusion coeff. caused by the larger mass of A^{41} was deduced and found to be 0·6%. The experimental values are compared with several theoretical calculations. In particular, it is shown that use for A of an inverse power model ($V \propto r^{-\nu}$), with different values of ν ascribed to different temp. ranges, is not permissible since widely different values of ν at the same temp. can be obtained from different experimental data. The experimental figures agree very well with numerical calculations by Hirschfelder, Bird and Spotz based on an interaction potential of the form

$$4E[-(r_0/r)^6 + (r_0/r)^{12}]$$

[Abstr. 480 (1949)]. A.

533.16

1563. Viscosity in moderately diluted gases as a consequence of the retarded establishment of energy equilibrium. M. KOHLER. *Z. Phys.*, **125** (*Nos* 11–12) 715–32 (1949) *In German.*

From gas-kinetic considerations it is shown that the gas viscosity η can be regarded as due to the finite relaxation time of the translational energy. This time is about 1·27× the collision time. The volume viscosity μ is caused by the relaxation of the internal degrees of freedom. When the rotations are fully and the oscillations only slightly excited the contributions of the two relaxations are additive: $\mu = \mu_r + \mu_{os}$. μ is independent of pressure; μ_r is usually (except for H, D) of the same order of magnitude as η, whereas μ_{os} is several orders of magnitude larger. Approximate values of $\mu_r/\eta = 0{\cdot}6$ and 1·3 for N and NH_3 respectively are calculated from measured values of sound absorption at frequencies $\gg 1/$(relaxation time of oscillations), and $\mu_{os}/\eta =$ 2 350 for 0 from this relaxation time and the contribution of the oscillations to the specific heat.

H. LONDON

533.16 : 536.75

1564. Viscosity and other physical properties of gases and gas mixtures. J. O. HIRSCHFELDER, R. B. BIRD AND E. L. SPOTZ. *Trans. Amer. Soc. Mech. Engrs*, **71**, 921–37 (*Nov.*, 1949).

A comprehensive review of the theoretical tools available for the calculation of the thermodynamic properties of gases and gas mixtures at finite, moderate pressures. Reviews information collected during the past two decades and shows the extent to which it can be correlated and systematized by means of molecular theory. The paper outlines a new method of formulating and predicting the viscosity and other transport properties of gases and gas mixtures at sufficiently low pressures. Extensive tables illustrate the method so that the user is enabled to calculate the viscosity and other transport properties of a large class of technically important gases and gas mixtures with very little labour. A.

533.2 : 531.15

An extension of Hamy's theorem to rotating gaseous bodies. *See Abstr.* 1515

533.43 : 526.943

1565. Elevation surveying by precision barometric means. A. A. STRIPLING, R. A. BRODING AND E. S. WILHELM. *Geophysics*, **14**, 542–57 (*Oct.*, 1949).

A sensitive instrument for measuring changes in atmospheric pressure and adapted for use in elevation surveying is described. Differences in atmospheric pressure are measured by measuring the changes in volume of an isothermal gas chamber that are required to maintain the chamber at atmospheric pressure. The instrument is sensitive to a change in atmospheric pressure equivalent to an elevation difference of 0·1 ft. Some of the theoretical aspects relating barometric pressure to elevation are reviewed, and the practical limitations imposed by the erratic nature of the atmosphere are discussed. Two field techniques are described, and a typical survey presented. A.

533.51

1566. Performance data for high vacuum pumps. W. H. KOHL. *Iron Age*, **164**, 59–63 (*July* 28, 1949).

Data are tabulated on high vacuum pumps, including performance characteristics, costs, manufacturers, greases, oils, fluids and other pertinent information. The tables are intended to serve as a guide for users. The author urges standardization of the usage of terms and test procedures which apply to the evaluation of high vacuum pumps.

METROPOLITAN-VICKERS

533.6.011

1567. The aerodynamics of porous sheets. G. I. TAYLOR AND R. M. DAVIES. *Aero. Res. Coun.* (*Min. of Supply*) *Rep. Mem.* (*No.* 2237) (*April*, 1944).

Measurements of the air resistance of perforated sheets, gauze and some fabrics are described. The results are compared with theories which are based on an arbitrary assumption about the pressure on the down-wind side of the porous obstruction. These theories are not found to be in good agreement with observation. Good agreement with a theory based on another assumption is found. Measurements of the drag coeffs. of flat circular sheets of porous material dropped as parachutes in air and in water give results which are in fair agreement with theoretical prediction.

A.

533.6.011

1568. Air resistance of a flat plate of very porous material. G. I. TAYLOR. *Aero. Res. Coun.* (*Min. of Supply*) *Rep. Mem.* (*No.* 2236) (*Jan.*, 1944).

Two ways of estimating the resistance of a flat plate of very porous material are given.

A.

533.6.011

1569. Steady flow in the laminar boundary layer of a gas. C. R. ILLINGWORTH. *Proc. Roy. Soc. A*, **199**, 533–58 (*Dec.* 7, 1949).

If the boundary-layer equations for a gas are transformed by Mises's transformation, as was done by Kármán and Tsien for the flow along a flat plate of a gas with unit Prandtl number σ, the computation of solutions is simplified, and use may be made of previously computed solutions for an incompressible fluid. For any value of the Prandtl number, and any variation of the viscosity μ with the temperature T, after the method has been applied to flow along a flat plate (a problem otherwise treated by Crocco), the flow near the forward stagnation point of a cylinder is calculated with dissipation neglected, both with the effect of gravity on the flow neglected and with this effect retained for vertical flow past a horizontal cylinder. The approximations involved by the neglect of gravity are considered generally, and the cross-drift is calculated when a horizontal stream flows past a vertical surface. When $\sigma = 1$, $\mu \propto T$, and the boundary is heat-insulated, it is shown that the boundary-layer equations for a gas may be made identical, whatever be the main stream, with the boundary-layer equations for an incompressible fluid with a certain, determinable, main stream. The method is also applied to free convection at a flat plate (with the heat of dissipation and the variation with altitude of the state of the surrounding fluid neglected) and to laminar flow in plane wakes, but for plane jets the conditions $\sigma = 1$, $\mu \propto T$, previously imposed by Howarth, are also imposed here in order to obtain simple solutions.

A.

533.6.011

1570. Unsteady compressible flow in two dimensions. T. V. DAVIES. *Proc. Roy. Soc. A*, **199**, 468–86 (*Dec.* 7, 1949).

The paper presents an alternative to the well-known linear perturbation theory of 2-dimensional compressible flow by superposing a small perturbation upon the correct basic irrotational flow pattern. When the latter is known the perturbation field is determined by partial differentiation of a function which satisfies a linear partial differential equation of the second order. A particular example of the theory is investigated in which the basic flow is circular and bounded internally by an oscillating circular cylinder, and the author restricts himself to the problem of wave propagation.

A.

533.6.011

1571. Correlated incompressible and compressible boundary layers. K. STEWARTSON. *Proc. Roy. Soc. A*, **200**, 84–100 (*Dec.* 22, 1949).

The boundary-layer equations for a compressible fluid are transformed into those for an incompressible fluid, assuming that the boundary is thermally insulating, that the viscosity is $\propto$ the absolute temp., and that the Prandtl number is unity. Various results in the theory of incompressible boundary layers are then taken over into the compressible theory. In particular, the existence of "similar" solutions is proved, and Howarth's method for retarded flows is applied to determine the point of separation for a uniformly retarded main stream velocity. A comparison with an exact solution is used to show that this method gives a closer approximation than does Pohlhausen's.

A.

533.6.011.5

1572. Focusing effects in two-dimensional, supersonic flow. R. E. MEYER. *Philos. Trans. A*, **242**, 153–71 (*Dec.* 20, 1949).

The steady, supersonic, irrotational, isentropic, 2-dimensional, shock-free flow of a perfect gas is investigated by a new, geometrical method based on the use of characteristic co-ordinates.

A.

533.6.011.5 : 534.222.2

1573. The consistency relations for shock waves. T. Y. THOMAS. *J. Math. Phys.*, **28**, 62–90 (*April*, 1949).

Continuing a previous paper [Abstr. 6017 (1949)], it is shown that for a uniform incident stream there exist relations of the form $K_{(n)} = G_n(M, \alpha)k_{(n)} + H_n$ where $K_{(n)}$ denotes the nth derivative (w.r.t. distance along the streamline) of the curvature K of the stream line, and $k_{(n)}$ the corresponding parameter for a shockline; G_n depends on the Mach no. M of the incident flow and the inclination α of the shockline, and H_n is a polynomial in k, H_0 being zero. Values of G_1 are presented in both tabular and graphical form, the range and interval of M and α corresponding with those used in tabulating $G_0(= K/k)$ in the previous paper.

A. SCHOFIELD

533.6.011.5 : 534.222.2

1574. On conditions for steady plane flow with shock waves. T. Y. THOMAS. *J. Math. Phys.*, **28**, 91–8 (*July*, 1949).

Theoretical. It is shown that the shock line at the apex of an obstacle will be fixed in the plane of the flow and the flow behind the shock line will be steady provided that the inclination α of the shock line relative to the obstacle is non-singular with respect to the Mach no. M of the incident flow. A value of α is called singular with respect to M (for $M > 1$) when any one of the functions $G_n(M, \alpha)$ has a zero (see preceding Abstr.). A. SCHOFIELD

533.6.013.22

1575. A circuit for compensating hot wires used in the measurement of turbulence. R. W. F. GOULD. *Aero. Res. Coun.* (*Min. of Supply*) *Rep. Mem.* (*No.* 2240) 7 *pp.* (*Aug.*, 1945).

533.6.08

1576. A shielded hot-wire anemometer for low speeds. L. F. G. SIMMONS. *J. Sci. Instrum. Phys. Ind.*, **24**, 407–11 (*Dec.*, 1949).

A low-speed anemometer is described which comprises an electrically heated wire and a thermocouple contained in a double-bore silica tube. In an air current the temp. change caused by heat loss is registered by the thermocouple and, when the instrument is suitably calibrated, the e.m.f. developed serves as a measure of the speed of flow. A.

MOLECULAR THEORY OF GASES 533.7

533.73

1577. On the distribution of kinetic energy of particles formed at sources in gaseous systems. E. V. STUPOCHENKO. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 3) 447–50 (1949) *In Russian.*

Theoretical. It is assumed that the no. of sources is small and the gas-density is low, so that the distribution of the molecular velocities in the main body of gas is negligibly different from Maxwellian. Each newly-formed particle, bearing initial energy E_0, finds its way after a sufficiently large no. of collisions, into this Maxwellian "background" upon which the particle-energy distribution is superposed. The special case considered is that in which the sources have existed long enough to provide a steady stream of particles into the "background"; the newly-formed particles are assumed equal in mass to the molecules of gas in which they are formed. The distribution of particle energy E is calculated for these conditions. It takes a particularly simple form when $E > E_0 \gg kT$ (k = Boltzmann's const., T = temp. of main body of gas): in this case the energy distribution differs from Maxwellian only by a constant multiplying factor. A. SCHOFIELD

533.73

1578. On the distribution of kinetic energy in systems with sources of particles. E. V. STUPOCHENKO. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 4) 635–8 (1949) *In Russian.*

Theoretical. An earlier investigation (preceding Abstr.) is extended to allow for departure from Maxwellian distribution of velocities in the main body of gas. All newly-formed particles are assumed similar, each bearing initial energy E_0. Introducing an energy parameter $x = E/kT$ (where E = particle energy, k = Boltzmann's const., T = ambient gas temp.) it is shown that when $\varepsilon^{-x} \ll 1$ the frequency function $f(x)$ (for $x < x_0$) is defined by $f(x) = [\rho_0 + BI(x)(x - \frac{3}{2})]f_0(x)$ where ρ_0 is the total no. of particles, $B = Nm^{\frac{1}{2}}/(2\pi kT)^{\frac{1}{2}}D^2\rho_0$, $I(x) = \int_{\eta}^{x}(x + \frac{1}{2})^{-2}(x - \frac{3}{2})^{-2}\varepsilon^{-x}dx$ and $f_0(x)$ is the Maxwellian frequency function. In the expressions for B and I, N is the rate of formation of new particles, m and D the particle-mass and dia., and η a const., approx. = 2. For $x > x_0$ the frequency function differs from that given above only in that $I(x)$ is replaced by $I(x_0)$. A. SCHOFIELD

VIBRATIONS . ACOUSTICS 534

534.01 : 517.93 : 621.3.015.4

On the phenomenon of subresonance according to the equation of van der Pol. *See Abstr.* 1379

534.1

1579. Experimental determination of oscillations of two or three coupled elements without damping. R. KOŠŤÁL. *Publ. Fac. Sci. Univ. Masaryk, C* (*Ser.* 2) (*No.* 303) 3–17 (1948) *In Czech.*

The conditions for simple oscillatory movements of coupled elements is determined. The formulae are developed for two elements without damping which are coupled by elongation and acceleration. It was found that for a simple oscillatory movement the relation between the initial elongations must be the same as that between the initial velocities; this relation is a function of the degree of coupling. For a certain degree of coupling simple oscillation only occurred for a certain ratio of the initial elongations. Formulae were developed for 3 equal elements coupled by elongation. The theoretical results obtained were checked by means of 3 equal torsion pendulums which were coupled by elongation and also by means of two torsion pendulums which were likewise coupled by elongation. In the first case the conditions necessary for obtaining simple oscillations does not depend on the degree of coupling, whilst in the case of two coupled pendulums the degree of coupling does influence these conditions and must be taken into consideration. E. GROS

534.11

1580. On the evaluation of certain integrals occurring in the theory of the freely vibrating circular disk and related problems. C. J. BOUWKAMP. *Proc. K. Ned. Akad. Wet.*, **52** (*No.* 9) 987–1005 (1949).

534.115

1581. The acoustic characteristics of conical pipes. M. MOKHTAR AND G. A. MESSIH. *Proc. Phys. Soc. B*, **62**, 793–9 (*Dec.*, 1949).

Describes an experimental investigation on slightly tapering conical pipes used as sound transmitters,

undertaken in order to determine their acoustic characteristics, their end corrections and the pressure variation along the inside of the pipes. A hot wire anemometer and a Pitot pressure tube were used for recording particle velocity and pressure variation in the acoustic field. The results obtained for the resonant frequencies show fair agreement with the theoretical formula $kr = -\tan kl$, where r is the radius of the throat of the conical pipe, l is its slant length and $k = \omega/c$, ω being the angular frequency and c the velocity of sound. The recording of the acoustic pressure along the axis of the conical pipes shows that the nodes inside are places of minimum but not zero pressure, and that they are not equidistant. The end corrections are deduced from these pressure curves. The correction is always positive, being less than that of a cylindrical pipe of diameter equal to that of the mouth of the cone. It increases with the angle of the cone and with the order of the overtone to which the conical pipe resonates. A.

534.154

1582. Measurement of vibration. M. WEBER. *Helv. Phys. Acta*, **22** (*No.* 4) 425–56 (1949) *In German.*

The theoretical basis of instruments for measuring vibration is given. The construction and performance of accelerometers are described and mention is made of piezo-electric accelerometers for measuring vibrations in the frequency range 0–400 c/s.

H. J. H. STARKS

534.154 : 621.317.39 : 621.396.611.21

1583. Vibration detection by a quartz oscillator. Y. L. YOUSEF AND F. SULTAN. *Rev. Sci. Instrum.*, **20**, 533 (*July*, 1949).

The vibrating material forms one plate of a small capacitor connected across the tuned circuit of a crystal oscillator. The circuit is tuned slightly off the crystal frequency so that the oscillator anode current varies very rapidly with capacitance (80 mA/pF). The p.d. across an anode resistance is amplified and applied to a c.r.o. The magnification from vibrator to c.r.o. screen is 10^5. C. F. BROCKELSBY

534.2

1584. On the attenuation of plane waves by obstacles of arbitrary size and form. H. C. VAN DE HULST. *Physica*, **15**, 740–6 (*Sept.*, 1949).

Proves the existence of a relation between the amount of extinction of a plane wave by an arbitrary obstacle and the complex amplitude of the wave scattered under the angle $\theta = 0$. The relation holds for any size, shape, or composition, of the obstacle. It may be applied to light, sound, and electron scattering. It may be generalized to include polarization effects. Some examples treated are the extinction by spherical particles and the diffraction by large particles of arbitrary shape. In certain problems, computation of the extinction by means of this relation is more rapid than by other methods. A.

534.21

1585. Mechanical waves in elastic, viscous and plastic media, and in piezoelectric materials.. R. MERCIER. *Helv. Phys. Acta*, **22** (*No.* 4) 405–7 (1949) *In French.*

When an isotropic material has elastic, viscous and plastic properties, these properties will affect the localized dilatation accompanying the propagation of mechanical waves as well as the localized sli The tensor equations are given, and it is stated th they can be verified for purely elastic materials. Th formulae are then applied to the propagation sonic or ultrasonic waves in liquids of low viscosit and the resultant damping is shown to be in agre ment with that obtained by Stokes, which has bee verified frequently by experiment. An attempt made to apply the theory to piezoelectric materia which have purely elastic properties. A. C. WHIFFI

534.21 : 534.321.

1586. Measurements on the absorption of ultra sonics in water. A. VAN ITTERBEEK AND P. SLOOT MAKERS. *Physica*, **15**, 897–905 (*Oct.*, 1949).

The absorption of sound in water was measure with the balance method at a frequency of 1 500 kc/s The various causes of errors of this method are dis cussed. For α/ν^2 (α = absorption coeff., ν = fre quency) a value of $55 \cdot 10^{-17}$ sec²/cm at 22°c wa obtained, which agrees very well with the valu obtained for high frequencies ($\geqslant$10 Mc/s). Th absorption in NaCl-water solution was also measure as a function of the concentration. A

534.21 : 534.321.

1587. An optical method for determining th absorption of ultrasonic waves in (nontransparent materials of low acoustic impedance. T. HÜTER AN R. POHLMAN. *Z. angew. Phys.*, **1**, 405–11 (*June*, 1949 *In German.*

A survey is made of the common methods o measuring the absorption of ultrasonic waves i liquids and certain solid bodies. A description i given of two optical methods of measuring wave absorption suitable for materials of low acoustic impedance and high absorption. Both methods depend on the refraction of light by the ultrasonic waves and the effect on the distribution of light intensity in the spectrum. The ultrasonic waves, generated by a quartz crystal, are transmitted by water to the absorbing medium and then through water again on the far side of the medium. The collimated light beam traverses the water on the side of the medium remote from the quartz generator, and the broadening of the spectrum due to the vibration gives a measure of the intensity of the vibration. An accuracy of 5% is claimed at frequencies below 1 Mc/s. For higher frequencies photometric measurements are made of the intensity of the light. A. C. WHIFFIN

534.22

1588. Ultrasonic velocities in mineral acids. J. BHIMASENACHAR AND T. S. RAO. Letter in *Curr. Sci.*, **18**, 372 (*Oct.*, 1949).

The velocities of propagation of ultrasonic waves at 2·75 Mc/s have been determined in HCl, H_2SO_4 and HNO_3 by the Debye–Sears diffraction method. A special arrangement of transmitter was used to prevent the acids attacking the crystal holder and the silvering on the piezoelectric crystal. Sn foil was placed between the bottom of the crystal and a glass plate forming the lower end of a tube. A drop of oil between the foil and the plate gave a good acoustical path, and the whole arrangement was lowered until the glass plate just touched the surface of the acid under investigation. A. C. WHIFFIN

534.22

1589. Measurements of the velocity of sound in liquid argon and liquid methane. A. VAN ITTERBEEK AND L. VERHAEGEN. *Proc. Phys. Soc. B*, **62**, 800–4 (*Dec.*, 1949).

The ultrasonic velocity in liquid A and CH_4 has been measured between their boiling and melting points and the ratio of specific heats calculated. The compressibilities and degrees of association have also been calculated and compared with the results obtained for other liquefied gases (H, He). A.

534.22 : 541.64

Rate of propagation of ultrasonic waves in macromolecules. *See Abstr.* 2061

534.221

1590. Temperature variation of the velocity of sound in light and heavy water. P.-P. HEUSINGER. *Naturwissenschaften*, **36** (*No.* 9) 279–80 (1949) *In German.*

The velocities were measured by an extension of the optical method of Hiedemann and Bachem [*Z. Physik*, **94**, 68 (1935)]. The whole range from 0°C to 100°C was examined, and it was found that the velocity in D_2O is about 7% < in H_2O. In the former the velocity has a maximum at 75·1°C, and in the latter at 73·4°C. P. M. DAVIDSON

534.222

1591. Sound propagation in chemically active media. L. LIEBERMANN. *Phys. Rev.*, **76**, 1520–4 (*Nov.* 15, 1949).

A fluid containing chemically active ingredients in equilibrium may exhibit unique physical properties: the compressibility may depend on the rate of compression; similarly the specific heat may depend on the rate of temp. change. This rate dependence arises from the finite reaction rate of the chemical components. One phenomenon resulting from this behaviour is the anomalous absorption and dispersion of sound. Expressions are given relating the chemical reaction rate, the equilibrium constant, and other chemical parameters, to the acoustical properties of the fluid. As an illustration of these relationships the unusual sound absorption in aqueous $MgSO_4$ solution is discussed. Calculation shows that the partial compressibility associated with the ionization process is of the correct magnitude to explain the observed absorption. A.

534.231.3 : 531.719

Acoustic impedance of ring-shaped slit. *See Abstr.* 1520

534.24 : 538.566 : 621.396.11

Reflection of spherical waves on "weak" separating surfaces. *See Abstr.* 1883

534.24 : 538.566 : 621.396.11

Reflection of spherical waves on the plane separation of two media. *See Abstr.* 1884

534.232

1592. Theory of focusing radiators. H. T. O'NEIL. *J. Acoust. Soc. Amer.*, **21**, 516–26 (*Sept.*, 1949).

An approximate theory has been derived describing part of the sound field due to a concave spherical radiator, vibrating with uniform normal velocity; the radius a of the circular boundary is assumed to be $\geqslant$ the wavelength and the depth of the concave surface. The theory describes the distribution of pressure, particle velocity, and intensity along the axis of symmetry and in the vicinity of the focal plane, perp. to the axis at the centre of curvature. It is shown that the ratio of the intensity at the centre of curvature to the average intensity at the radiating surface is $\simeq (2\pi h/\lambda)^2$ where h is the depth of the concave surface and λ is the wavelength. This ratio can be made very large by suitable choice of dimensions, and the focusing is then very sharp. The point of greatest intensity is not at the centre of curvature but approaches it with increasing $kh = 2\pi h/\lambda$, and the greatest intensity is not much greater than the intensity at the centre of curvature except when kh is small. In the central part of the focal plane, at angle θ from the axis, the pressure is approx. $\propto (2/ka \sin\theta)J_1(ka \sin\theta)$, which is equivalent to the directivity function of a flat circular piston of radius a, for the region at large distance from the piston. The calculations are in reasonable agreement with Willard's experimental data for a 5 Mc/s concave quartz crystal [Abstr. 6035 (1949)], when allowance is made for the non-uniform normal velocity of the crystal. A.

534.232 : 621.395.623.7.08

1593. Physical measurements of loudspeaker performance. P. S. VENEKLASEN. *J. Soc. Mot. Pict. Engrs*, **52**, 641–56 (*June*, 1949).

Measurements on large loudspeaker systems must be made at large distances and at l.f. A description and photographs are given of the set-up used in the open where the speakers may be hoisted 40 ft in the air. The effect of ground reflections can be calculated. An oscillator sweeping from 30 to 16 000 c/s is used and the sound from the speaker is picked up by a 640 AA microphone and recorded on a high-speed recorder. Response curves are given for various angles off axis. The establishment of distortion limits is discussed and also the importance of a smooth response over a limited frequency range rather than a wide response varying many db in output over the range. B. B. AUSTIN (R)

534.26

1594. The non-stationary case of the problem of the diffraction of a plane wave at a rectilinear edge. A. A. KHARKEVICH. *J. Tech. Phys., USSR*, **19**, 828–32 (*July*, 1949) *In Russian.*

A solution is given for the diffraction of a plane wave impinging at an arbitrary angle on a semi-infinite sheet barrier in a fluid. D. H. WHIFFEN

534.26

1595. The construction of a qualitative diffraction diagram. A. A. KHARKEVICH. *J. Tech. Phys., USSR*, **19**, 822–7 (*July*, 1949) *In Russian.*

A discussion of the general boundary conditions for the diffraction of longitudinal elastic waves at barriers in a fluid medium. D. H. WHIFFEN

534.321.4

1596. Organ pipe tones. D. M. A. MERCER. *Nature, Lond.*, **164**, 783 (*Nov.* 5, 1949).

Brief summary of the contents of two papers [Ingerslev and Frobenius, Abstr. 2752 (1948) and K. T. Kuhn (Berlin dissertation, microfilm available)] reporting the effect on the overtones, etc., of variations

in diameter and mouth dimensions of organ pipes. The airflow at the mouth was also examined stroboscopically by the Schlieren method.

534.321.9

1597. Internal examination of materials by ultrasonic-optical pictures. R. POHLMAN. *Z. angew. Phys.*, **4**, 181–7 (*Sept.*, 1948) *In German.*

Diagrams are given showing that objects can be illuminated by sound as by light and then focused on to screens by lens systems. A cell has been devised for changing sound waves into light to give an optical picture, the cell consisting of a thin membrane on the side nearest the sound and a glass plate on the observer's side. The cell contains a liquid having in suspension fine, flat, metallic particles. The particles are vibrated by the sound waves, and when illuminated by parallel light on the observer's side reflect the light, the intensity of the reflected light being dependent on the amplitude of the vibration of the particles. In this way, shadow photographs can be taken of bodies "illuminated" by sound waves, and, when suitable frequencies are employed, the bodies can be examined for flaws by inspection of the intensity of the shadow. A. C. WHIFFIN

534.321.9 : 541.18.047

1598. Agglomeration of smoke, fog, or dust particles by sonic waves. H. W. ST. CLAIR. *Industr. Engng Chem.*, **41**, 2434–8 (*Nov.*, 1949).

The forces acting to cause sonic agglomeration are discussed. The more important factors seem to be a combination of the following: (1) covibration of particles in a vibrating gas: (2) attractive and repulsive hydrodynamic forces between neighbouring particles; and (3) radiation pressure. A.

534.84

1599. Room acoustics. E. WINTERGERST. *Z. angew. Phys.*, **1**, 428–36 (*June*, 1949) *In German.*

The paper is divided into 3 sections: (1) Reflection from walls and ceiling, (2) Reverberation and (3) Variation of absorption coeff. with frequency. In part (1) consideration is given to the shaping of the rooms, e.g. rooms with curved walls, and the corrugation of the wall surfaces. In (2) the characteristics of rooms designed for speech and music are dealt with, the reverberation time for rooms as a function of volume, empty and filled by an audience being shown graphically. The subject is treated theoretically. In section (3) an interesting example is given of a room having a controllable reverberation time, by the use of walls covered with rotatable cylinders. The latter are arranged to be reflecting from one half of the cylinder (180°) and absorbent over the other half (180°). As the cylinders are rotated more or less of the absorbent surface is exposed as required. An additional advantage of this arrangement is that the wall surface is corrugated as required in part (1). A. B. WOOD

534.843

1600. Reverberation time and necessary sound-power for occupied rooms. E. DE GRUYTER. *Bull. Ass. Suisse Elect.*, **40**, 757–61 (*Sept.* 17, 1949) *In German.*

The author gives a new interpretation of Sabine's formula for the reverberation time of a room. He introduces a new reverberation constant which independent of the dimensions of the room. E analogy with power considerations in an electric circuit he establishes a formula for the acoustic power required in relation to the constants reverberation. In conclusion, the paper refers t psychological factors bearing on the problem good acoustics, particularly in its relation to moder electro-acoustic transmission. A. B. WOO

534.85 : 621.395.623 : 621.317.3

1601. Compliance meter for pickups. A. M WIGGINS. *Electronics*, **22**, 94–5 (*Oct.*, 1949).

The vibrating system of the instrument is a cant lever reed which serves as the armature of a magneti driving system. To the reed is cemented a piezo electric ceramic slab in such a manner that th voltage developed, as indicated by a high-impedanc valve-voltmeter, is ∝ the reed displacement. Th meter is adjusted to give full-scale deflection whe the driven reed is unloaded, and when the stylus loa is applied the reading will fall. Analysis shows hov the instrument can be calibrated in terms of com pliance after calculating the unloaded reed compliance from its dimensions and modulus. The drive i supplied by a variable-frequency oscillator. Account must be taken of the reed mass if the test frequency is $> \frac{1}{3}$ of the resonant frequency of the reed, whil no measurement should be made within 100 c/s o the resonant frequency, since in this region th mechanical resistance of the system cannot be ignored A method of using the instrument to determine th effective mass of a tone arm is also shown.

H. G. M. SPRATT (R

534.861 : 621.396.7 : 621.39

1602. Fundamental electroacoustic principles for the reproduction of an extended audio frequency range W. FURRER, A. LAUBER AND P. WERNER. *Tech. Mitt. Schweiz. Post-Telegr.-TelephVerw.*, **27**, 3–14 (*Feb.*, 1949) *In German.*

A review of the acoustical problems involved in the extension of the broadcast frequency range to 15 Kc/s. Microphones, loudspeakers, studios and amplifiers are considered and it is considered that the latter are generally satisfactory, while the microphone and loudspeaker need improvement. Microphones must, in general, be small, and the distortion of the sound field may be explored with the aid of a large-scale model. Polar diagrams and axial frequency responses are quoted for a number of different types of speakers and "tweeters," including the coaxial multicellular horn and "woofer" type.

POST OFFICE (R)

534.861.1 : 621.396.712.3

1603. The broadcasting of orchestras. F. W. ALEXANDER. *B.B.C. Quart.*, **4**, 15–25 (*July*, 1949).

Discusses the importance in the placing of the microphone in a hall. This is generally high up and close to the orchestra and not near seats which are known by the audience to give the best results. The effect of the relative amounts of direct and indirect or reverberant sound is considered and it is pointed out that the latter should be independent of frequency. Experiments show that the first reflections from surfaces near the orchestra are the most important in artistic reproduction. The reverberation time for

large halls is $\sim 1 \cdot 5$–2 sec. The positioning of the microphone is also decided by its type and polar diagram, i.e. "figure 8," cardioid or omni-directional. The dynamic range of orchestras is discussed and the problem of compressing a range of about 50 db into the permitted 20 db. Diagrams are given showing the positioning of microphones in relation to the orchestral performers, and also of introducing artificial reverberation from an echo room. B. B. AUSTIN (R)

OPTICS . RADIATION . SPECTRA 535

535.214.6

1604. On photophoresis, and an effect of sunlight in causing a rotation of matter in a vacuum. F. EHRENHAFT AND E. REEGER. *C.R. Acad. Sci., Paris*, **229**, 515–17 (*Sept.* 5, 1949) *In French.*

Gives photographs of the paths taken by graphite particles *in vacuo* $\sim 5 \cdot 10^{-6}$ mm Hg and also between $4 \cdot 10^{-2}$ mm and 10 mm. These paths are circles, helices or epicycloids, depending on the direction of the incident light; a magnetic field is found to influence the path. N. CORCORAN

535.222

1605. A preliminary determination of the velocity of light. E. BERGSTRAND. *Ark. Mat. Astr. Fys. A*, **36**, *Paper* 20, 11 *pp.* (1949).

An instrument called the geodimeter developed for surveying has been used to measure the speed of light. The light is modulated at 8 Mc/s by a Kerr cell and received in a photo cell, the sensitivity of which is modulated at the same frequency. The beam is also modulated at 50 c/s to enable a sharp zero of intensity to be obtained instead of a flat min. Two base lines of approx. 9 000 m and 4 000 m were measured by ordinary means and then by the geodimeter. The combined errors of the two measurements are estimated at 5 cm in 10 km, giving an error of $\pm 1 \cdot 5$ km/s in the value of velocity. The mean value is 299 796 km/s, which is 20 km/s $>$ the generally accepted value, and in fairly close agreement with that obtained by Essen and Gordon–Smith by a cavity resonator method [Abstr. 2568 (1948)]. L. ESSEN

535.242.62

1606. A photoelectric reflectance comparator. H. R. HINDLEY AND E. J. LEATON. *J. Sci. Instrum. Phys. Ind.*, **26**, 396–401 (*Dec.*, 1949).

The instrument described compares the diffuse reflection of similar surfaces and assigns numerical values to small variations between them. It has a sensitivity rather better than that of the human eye. Two beams of light from a single source illuminate the specimens normally. The beams are interrupted alternately by a rotating shutter. Light reflected at 45° from the specimens falls on to a photocell, which thus alternately "looks" at each. If the specimens are not identical the output from the cell has an a.c. component of magnitude dependent on their difference. This a.c. component is separated from the d.c. component, amplified and indicated. Suitable optical filters are used. The meter has 4 ranges: the more closely matched the specimens the more sensitive is the appropriate setting and the more accurately can the measurement be made. The results are not correlated with the C.I.E. system. A.

535.243

1607. Photometric recorder for the infrared spectrum. R. ZBINDEN, E. BALDINGER AND E. GANZ. *Helv. Phys. Acta*, **22** (*No.* 4) 411–13 (1949) *In German.*

A double beam spectrometer is fitted with a "thermistor" bolometer (period = 0·006 sec) to receive the two beams alternately (at $8\frac{1}{3}$ c/s). After amplification (band pass, 3–40 c/s) the signals from the two beams are separated by a synchronous commutator and charge two condensers (time constant 1 sec. to reduce fluctuations); the ratio of voltages developed is measured by a self-balancing potentiometer (Brown recorder). Noise level is 1 μV at the bolometer. Recording time for $\lambda = 2 - 16\,\mu$ is 30 min. G. F. LOTHIAN

535.247.4

1608. Measurement of extremely small light intensities. P. S. FARAGO AND E. F. POCZA. *Publ. Univ. Tech. Sci., Budapest* (*No.* 1) 10–14 (1949).

Using a photocell with a dark current of 10^{-11} A, photocurrents $\sim 10^{-14}$ A can be detected by modulating the incident light with a suitable frequency (80, 120 and 260 c/s were used) and amplifying the resultant total current by a tuned circuit with bandwidth 1–3 c/s. For d.c. operation, the dark current of the cell may be balanced out with sufficient accuracy if very stable sources of supply are used. N. CORCORAN

535.313 : 621.397.5

1609. The Schmidt optical system. H. RINIA. *Bull. Ass. Suisse Elect.*, **40**, 580–5 (*Aug.* 20, 1949).

Various aberration types of different orders are discussed in detail. It is shown that O^5, O^4U and O^3U^2 (the last called the lateral spherical aberration —being different in the two main planes) are particularly important—where O is aperture and U field angle. A full geometrical analysis of the coma and the lateral spherical aberration is presented, and the two different designs of the corrector plate by Bouwers and Maksutov and by Hawkins and Linfoot are described. A. LANDMAN (R)

535.313.2

1610. Field correctors for parabolic mirrors. C. G. WYNNE. *Proc. Phys. Soc. B*, **62**, 772–87 (*Dec.*, 1949).

Optical systems to correct the oblique aberrations of large parabolic mirrors in astronomical telescopes are discussed. The earlier work of F. E. Ross on doublet lens correctors in the converging beam is extended, and the residual first order spherical aberration is shown to depend only on the power of the corrector, its elimination requiring an impracticably large power; these results are independent of the arrangement and the optical constants of the components, and are unaffected by aspherizing the lens surfaces. Correction by two aspheric plates is shown to lead to systems of relatively great length, with consequent heavy vignetting. Finally, systems are discussed consisting of a doublet lens with one aspheric plate or secondary mirror; such a secondary mirror may be used to correct field curvature, giving

corrector lenses which are afocal and therefore free from secondary spectrum, and the departure of the secondary mirror from the spherical form may be made zero by a suitable choice of the other variables. Details are given of the calculated performance of 4 3-component systems. A.

535.317.1

1611. The sagittal factor common to extra-axial rays and a new rapid method for the computation of such rays. A. CLEMENTI. *Rev. Opt.* (*Théor. Instrum.*) **28,** 537–47 (*Oct.*, 1949) *In French.*

The sagittal factor for any meridian ray is defined by $K_s = \cot\omega' - \cot\omega$, where ω, ω' are the angles the incident and emergent rays make with the axis. The position of the sagittal and tangential objects and images are then defined by their respective distances from the axis: i.e. y_s, y'_s and y_t, y'_t. Refraction formulae for these quantities are given in terms of K_s. This same factor occurs in both the sagittal and tangential cases. Transfer formulae are unnecessary. It is claimed that the use of the common "extra-axial factor," $K = K_s$, leads to economy in computation. A short historical note on astigmatism formulae is included. H. H. HOPKINS

535.317.4

1612. An instrument for measuring longitudinal spherical aberration of lenses. F. E. WASHER. *J. Res. Nat. Bur. Stand., Wash.*, **43,** 137–44 (*Aug.*, 1949).

An instrument is described that permits the rapid determination of longitudinal spherical and longitudinal chromatic aberration of lenses. Specially constructed diaphragms isolate successive zones of a lens, and a movable reticle connected to a sensitive dial gauge enables the operator to locate the successive focal planes for the different zones. Results of measurement are presented for several types of lenses. The instrument can also be used without modification to measure the small refractive powers of goggle lenses. A.

535.317.5 : 522.21

On the optics of the Schmidt camera. *See Abstr.* 1386.

535.317.9

1613. On the corrector plates of Schmidt cameras. E. H. LINFOOT AND E. WOLF. *J. Opt. Soc. Amer.*, **39,** 752–7 (*Sept.*, 1949).

Discusses the problem of designing the aspheric surface of a Schmidt camera so as to obtain optimum performance, in an agreed sense, over the field taken as a whole. A solution is obtained in a form which allows the optimum plate-profile to be quickly determined for a Schmidt camera of given aperture-ratio and field-size, working over a given spectral range. It is shown that at apertures near *f*/3 the optimum plate can be obtained by slightly decreasing the strength of an ordinary "colour-minimized" Schmidt plate, while in wide-field systems working at apertures near *f*/1, it is better to use a plate with neutral zone at the edge of the aperture. A.

535.323

1614. Refractive index of natural rubber for different wavelengths. L. A. WOOD AND L. W. TILTON. *J. Res. Nat. Bur. Stand., Wash.*, **43,** 57–64 (*July*, 1949).

The refractive indices of a prism of natural rubber have been measured at 5 different wavelengths in th visible region by the use of a spectrometer. Values the rate of change of index with temp. at each wav length have been computed for the range 19·5° 30·3°C. The Eykman equation in differential for is used to calculate the expansivity from the inde and its rate of change with temp. It is conclude that the 2-constant Cauchy and Sellmeier dispersio equations are inadequate to represent the dat The dispersion observed for rubber is found to b essentially the same as that of hydrocarbons similar structure but of low molecular weight.

535.32

1615. Refractive indices of thallium bromide-iodid crystals for visible and infrared radiant energ L. W. TILTON, E. K. PLYLER AND R. E. STEPHEN *J. Res. Nat. Bur. Stand., Wash.*, **43,** 81–6 (*July*, 1949

The refractive indices of 2 specimens of Tl Br- were measured at a constant room temp. of 27° from 0·577 to 39 μ by use of a minimum-deviatio spectrometer and a Perkin–Elmer infrared spectro meter equipped with a calibrated screw for operatio of the Littrow mirror. In order to cover the entir region over which the prisms are transparent, man known wavelengths were used, including lines of Hg Na, H and He for the visible region. A Cd–Hg lam was the source from 1 to 2 μ. From 2 to 39 μ variou absorption bands of carbon dioxide, water, methyl cyclohexane, polystyrene and polyethylene were used with a Globar as source, for the identification o wavelengths. A

535.32

1616. Characteristics of the temperature relation ship of the refractive index of light in liquids. S. S URAZOVSKIĬ AND P. M. CHETAEV. *Dokl. Akad. Nauk SSSR*, **67** (*No.* 2) 313–15 (1949) *In Russian.*

Using a modified Abbé refractometer which allowed determinations of accuracy of 5×10^{-5} to be made, the relation between the refractive index (μ of light and the temp. (T) of a series of liquids was studied. It was found that there is a definite break in the μ–T curve which corresponds to points o molecular-polymorphic transformation. This con firms similar results obtained for the surface tension temp. curve obtained previously [Urazovskiĭ and Chetaev, *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 1) 101–4 (1949)]. The present work, however, clearly shows that this phenomena does occur in the bulk of the liquid, not merely in the surface. These results therefore, demonstrate the existence of molecular polymorphic transformations in liquids. W. HUGHES

535.325

1617. Refractive index and Lorentz–Lorenz function of argon up to 2 300 atmospheres at 25°C. A. MICHELS AND A. BOTZEN. *Physica*, **15,** 769–73 (*Sept.*, 1949).

The refractive index was measured at 6 wavelengths in the visible region. From the experimental data the Lorentz–Lorenz function was calculated as function of density and pressure. A.

535.33

1618. Theory of complex spectra. IV. G. RACAH *Phys. Rev.*, **76,** 1352–65 (*Nov.* 1, 1949).

The calculation of the coeffs. of fractional parentage and of the energy matrices for the configurations f^n

is simplified very much by the use of the theory of groups. Tables of results are given. A.

535.33.071

1619. Effect of diffraction by the spectrograph slit on the energy distribution in a continuous spectrum. R. MICHARD. *Rev. Opt.* (*Théor. Instrum.*) **28,** 479–86 (*Aug.–Sept.*, 1949) *In French.*

It is shown by classical diffraction theory that the effects of diffraction may be neglected if the slit width exceeds a certain min. value, dependent on the wavelength and the dimensions of the original aperture.

N. CORCORAN

535.33.072

1620. A rapid automatic method of computing infra-red spectra for quantitative analyses. R. W. FOREMAN AND W. JACKSON, JR. *Instruments*, **22,** 497–9 (*June*, 1949).

The empty cell spectrum is first recorded and this record is followed manually with a pointer while the unknown spectrum is observed: connected to the pointer is a variable resistance which controls the total voltage on the potentiometer recorder (Brown) slidewire so that the % transmission is recorded directly. D. H. WHIFFEN

535.33.072

1621. Automatic plateholder for spectrographs. P. H. KECK. *Spectrochim. Acta*, **3** (*Nos* 5–6) 599–602 (1949) *In German.*

A weight-driven arrangement is described by which the plateholder of a spectrograph is moved on by a predetermined amount each time a knob is depressed. This can be coupled with a time switching device by which the plate is automatically shifted after each exposure. A. C. MENZIES

535.33.072 : 551.508.15

1622. A spectrophotometer with secondary electron multiplier for ozone measurements. S. F. RODIONOV AND A. L. OSHEROVICH. *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 5) 665–8 (1949) *In Russian.*

535.331

1623. Triplet intervals of beryllium and calcium. W. WATARI. *Progr. Theor. Phys.*, **4,** 314–16 (*July–Sept.*, 1949).

535.331

1624. The spectrum of trebly ionized thorium, Th IV. P. F. A. KLINKENBERG AND R. J. LANG. *Physica*, **15,** 774–88 (*Sept.*, 1949).

Investigations on the spectrum of the Th spark in the i.r. region result in the discovery of the $5\,^2F - 6\,^2D$ transitions, and it is proved by the Zeeman-effect that $5\,^2F$ is the ground term of the spectrum; the doublet separation is $4\,325{\cdot}38\ \text{cm}^{-1}$. The whole visible and u.v. regions are examined with a view to the pole-effect in order to isolate the Th IV-lines. Subsequently the pole-effect is studied in the vacuum region down to 1 540 Å; below this limit down to 340 Å the spectrum of the vacuum spark is measured. The existing analysis of Th IV is revised in the light of the newly obtained data. The chief outlines of the term scheme are confirmed, a few corrections introduced and a diagram of the correct terms is given. The ionization potential is 28·6 V approx. A.

535.331

1625. Intervals of Cl I, A II, K III, Ca IV ^2P. W. WATARI. *Progr. Theor. Phys.*, **4,** 312–13 (*July–Sept.*, 1949).

535.331 : 537.228.5

1626. The Stark effect of calcium. R. GEBAUER AND H. STEUL. *Z. Phys.*, **126** (*No.* 5) 465–80 (1949) *In German.*

A Ca electrode bombarded with positive ions forms a luminous cloud, to which electric fields up to 500 kV/cm were applied. In this way the Stark effect was measured of a large number of singlet-, triplet- and forbidden lines. Results are in satisfactory agreement with existing theoretical computations for those field intensities for which the latter are valid.

L. PINCHERLE

535.332

1627. Intervals of Si IV ^2P levels. S. TUTIHASI. *Progr. Theor. Phys.*, **4,** 317–18 (*July–Sept.*, 1949).

535.333

1628. The band spectrum of chromium bromide. V. RAMAKRISHNA RAO. *Curr. Sci.*, **18,** 338–9 (*Sept.*, 1949).

535.333

1629. The infra-red bands of strontium oxide. G. ALMKVIST AND A. LAGERQVIST. *Ark. Fys.*, **1,** *Paper* 22, 477–94 (1949).

The analysis shows that the system is a $^1\Sigma - {}^1\Sigma$ transition. The following 7 bands have been analysed: 4,1, 3,0, 3,1, 2,0, 1,0, 0,0 and 0,1. In the upper vibrational levels several perturbations were found. Some of the perturbations are rather considerable and they displace the positions of the heads and the origins. The band-constants derived are given. A.

535.333

1630. The red and green bands of magnesium oxide. A. LAGERQVIST AND U. UHLER. *Ark. Fys.*, **1,** *Paper* 21, 459–75 (1949).

The analyses show that the red and green systems have the same upper level. The red bands represent a $^1\Sigma^* - {}^1\Pi$, the green ones a $^1\Sigma^* - {}^1\Sigma$ transition. The vibrational constants are given, as well as a short discussion of the correlations between molecular states in MgO and atomic states in Mg and O is given. A.

535.333

1631. Structure of the Cameron bands of carbon monoxide. K. NARAHARI RAO. *Astrophys. J.*, **110,** 304–11 (*Sept.*, 1949).

The Cameron bands ($^3\Pi - {}^1\Sigma$) of CO were photographed in emission under high dispersion. From a study of their structure the following vibrational constants are derived for the ground state of the CO molecule: $\omega_e = 2\,170{\cdot}21\ \text{cm}^{-1}$; $\omega_e x_e = 13{\cdot}461\ \text{cm}^{-1}$; $\omega_e y_e = 0{\cdot}0308\ \text{cm}^{-1}$. The rotational constants B_v for the levels $v'' = 0$–4 can be represented by a formula of the form $B_v = B_e - a(v + \frac{1}{2})$. Finally, the present knowledge regarding the molecular constants for the ground state of the CO molecule is summarized. A.

535.338

1632. A new sum rule for the multiplet spectra. S. SENGUPTA. *Curr. Sci.*, **18,** 333–4 (*Sept.*, 1949).

The δ-sum rule [Kar and Sengupta, Abstr. 5330

(1949)], applicable to electrostatic interaction energies, is illustrated for the special case of some np^3 terms ranging from N I to Bi I. R. F. BARROW

535.338.332

1633. Study of the selective reflection of a hyperfine structure component of the line λ2537 by mercury vapour. J.-L. COJAN AND R. LENNUIER. *C.R. Acad. Sci., Paris*, **228**, 1409–10 (*May* 2, 1949) *In French.*

The increase in selective reflection is found to take place even at as low a pressure as 0·1 mm. It grows linearly with temp. to 170°C, remains stationary up to 300° and then increases rapidly. In earlier work at the higher pressures the hyperfine structure levels appeared broadened. It is shown that at lower pressures the increase in reflectivity is critically selective within the close neighbourhood of each hyperfine structure component only. Within a region of only 10^{-5} Å the reflectivity rises rapidly from practically zero to 0·7. The width of the isotope 202 component is established as less than 10^{-4} Å, which is 50 times < the corresponding Doppler width due to thermal effects and collision effects. The variation of reflecting width with pressure is investigated. The incident ray used was the 202 component radiation, isolated by a method formerly described [Abstr. 6884 (1949)]. By maintaining the Hg vapour in a magnetic field that can be varied the line profile can be studied.

S. TOLANSKY

535.338.332 : 539.153.4

Electron-nuclear potential fields from hyperfine structure. *See Abstr.* 1935

535.338.333

1634. The isotopic displacement and term scheme of Samarium (Sm I). P. BRIX. *Z. Phys.*, **126** (*No.* 5) 431–9 (1949) *In German.*

The frequency difference of the Sm^{152} and Sm^{154} lines in the spectral region between 5 000 and 7 200 Å was measured by means of a Fabry–Pérot interferometer. The displacements can be classified into 6 main groups, which agree with the term scheme suggested by Albertson [*Phys. Rev.*, **47**, 370 (1935); **52**, 644 (1937)]. Various multiplets could be identified. The main terms belong to either of the electronic configurations $(4f)^6(6s)^2$, $(4f)^6 6p6s$, $(4f)^5 5d(6s)^2$.

L. PINCHERLE

535.338.334

1635. Collision theories of pressure broadening of spectral lines. J. H. VAN VLECK AND H. MARGENAU. *Phys. Rev.*, **76**, 1211–13 (*Oct.* 15, 1949).

It is shown that in the calculation of absorption in the Lorentz collision theory, it is essential to include the work done impulsively by the electric field during the sudden changes of position at collision. This work was implicitly included in the theory of Van Vleck and Weisskopf, but these authors did not give the breakdown into work done between and at collision. It is verified that the shapes of spectral lines for a classical harmonic oscillator and also a Debye slow rotator are the same in absorption and spontaneous emission, provided the energy density obeys the Rayleigh–Jeans law. The usual proofs of equilibrium simply establish equality of the integrated absorption and emission, without examining the detailed balancing at individual frequencies, not necessarily near resonance. A.

535.338

1636. Characteristics of the first positive nitroge bands in a high temperature source. N. R. TAWDE AN V. D. DESAI. *J. Univ. Bombay*, **17**, 41–8 (*March*, 1949

Comparison of the vibrational intensity distributio in a point-o-lite and a discharge-tube source.

A. G. GAYDO

535.338.

1637. Dissociation energy of C_2. N. R. TAWDE *J. Univ. Bombay*, **17**, 9–11 (*March*, 1949).

Vibrational intensity distribution of Swan band in flames and discharges is measured. The popula tions in the upper vibrational levels are plotted logarithmically, against energy, and from the intercep on the energy axis and the flattening of the curv above $v' = 5$, a value of $D(C_2) = 4{\cdot}2 \pm 0{\cdot}1$ eV i deduced. [The calculations appear to require the tacit assumption that the sum of the transitio probabilities from each vibrational level is the same].

A. G. GAYDON

535.338.4

1638. Study of the excitation of a band system from a metal and its oxide. N. R. TAWDE AND A. G HUSAIN. *J. Univ. Bombay*, **17**, 12–22 (*March*, 1949).

Vibrational intensity distribution for BeO and AlO in C arc are compared using Be and Al as metal and oxide. Differences may be attributed to the bands being emitted by different regions of the arc in the two cases rather than to dependence on the chemical form of the substance being excited. Results are expressed as effective vibrational temperatures.

A. G. GAYDON

535.338.4

1639. Effect of alkali chlorides on the intensity of the cyanogen bands in carbon arc. P. S. MENE AND D. J. DESHMUKH. Letter in *Curr. Sci.*, **18**, 373 (*Oct.*, 1949).

535.338.4

1640. The band-spectrum of barium oxide. A. LAGERQVIST, E. LIND AND R. F. BARROW. Letter in *Nature, Lond.*, **164**, 923–4 (*Nov.* 26, 1949).

535.338.4

1641. The band spectrum of tantalum oxide. I. FERNANDO AND S. G. KRISHNAMURTY. Letter in *Curr. Sci.*, **18**, 371 (*Oct.*, 1949).

535.338.4 : 523.87

1642. Band systems of zirconium oxide (ZrO) in the ultra-violet. M. AFAF. Letter in *Nature, Lond.*, **164**, 752–3 (*Oct.* 29, 1949).

Three new systems have been investigated: (1) a singlet system with $\nu_e = 27\,217{\cdot}92$ cm^{-1}; (2) a triplet system, perhaps $^3\Delta \rightarrow {}^3\pi$, whose 0, 0 band lies in the region λλ3472–3507 Å; (3) a weak $^3\Pi \rightarrow {}^3\Pi$ system in the region 2 940–3 060 Å. The singlet system has also been observed in the spectra of late-type stars [*Astrophys. J.*, **106**, 288 (1947); **107**, 303 (1948); **109**, 109 (1949); also Abstr. 2918 (1949)].

R. F. BARROW

535.338.4 : 539.13 : 538.615

1643. The theory of molecular terms and their Zeeman splitting in the intermediate Hund's coupling case $b' - d'$, with an application to the 4d complex of He_2. I. KOVÁCS AND A. BUDÓ. *Hungar. Acta Phys.*, **1** (*No.* 4) 1–18 (1949) *In German.*

Expressions are derived for the term-values for all

values of the coupling constant and of the rotational quantum number. Formulae for the intensity distributions in the branches and for the Zeeman-splitting are also listed. R. F. BARROW

535.339

1644. Logarithmic focusing monochromator: application to the study of texture and deformations in crystals. J. BARRAUD. *C.R. Acad. Sci., Paris*, **229**, 378–80 (*Aug.* 1, 1949) *In French.*

The monochromator already described [Barraud, *C.R. Acad. Sci., Paris*, **214**, 795–7 (1942)] is applied to study thin samples of mica. Imperfection is shown by a waviness of the image of the source, the waviness increasing with distance from the equatorial layer line. The geometrical theory is given.

A. J. C. WILSON

535.34

1645. Light absorption on thin layers of silver halides. B. BARSHCHEVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **65** (*No.* 1) 25–8 (1949) *In Russian.*

Experiments on the absorption of light in layers of AgI and AgBr of 10^{-6}–10^{-5} cm thickness, with wavelengths of 578–254 mμ, indicate appreciable absorption in the visible spectrum. Curves of the coeff. of absorption are given, indicating the great decrease in the photo-conductivity of Ag halides with increasing thickness of the layer; a negative (anomalous) photoelectric effect is also possible. This anomaly is the possible explanation of the origin of the latent image produced in AgBr. INDEX AERONAUTICUS

535.343

1646. The infra-red absorption spectra of propane-D-1 and propane-D-2. L. FRIEDMAN AND J. TURKEVICH. *J. Chem. Phys.*, **17**, 1012–15 (*Nov.*, 1949).

535.343

1647. Infra-red spectra of propane, 1-deuteropropane, and 2-deuteropropane and some revisions in the vibrational assignments for propane. H. L. MCMURRY, V. THORNTON AND F. E. CONDON. *J. Chem. Phys.*, **17**, 918–22 (*Oct.*, 1949).

535.343 : 539.132

1648. Vibration-rotation bands of allene. C. H. MILLER AND H. W. THOMPSON. *Proc. Roy. Soc. A*, **200**, 1–9 (*Dec.* 22, 1949).

The vibrational absorption spectrum of allene has been reinvestigated using a new grating spectrometer of high resolving power. The rotational structure of many of the bands has been measured and discussed in relation to the geometrical structure of the molecule. The perpendicular-type bands associated with absorption of the fundamental frequencies of degenerate oscillations show features of particular interest. Two of these bands provide an elegant example of a type of Coriolis perturbation which results in an unusual arrangement of the Q branches in each band. A.

535.343 : 539.132

1649. Vibration spectra of hydrocarbon molecules. II. Skeletal frequencies in certain branched paraffins. D. M. SIMPSON AND G. B. B. M. SUTHERLAND. *Proc. Roy. Soc. A*, **199**, 169–83 (*Oct.* 25, 1949).

[See Abstr. 2428 (1949)]. Saturated paraffins containing the terminal grouping $(CH_3)_3$ C . . . show strong absorption bands in the infrared at 1 250 and 1 200 cm^{-1}, while those containing the terminal grouping $(CH_3)_2$ CH . . . show strong bands at 1 170 and 1 145 cm^{-1}. It has been shown that these and other characteristic frequencies should be assigned as vibrations of the carbon skeleton of these structural units. Further, by using a simple valency force field on the model molecules X_3YZ and X_2WZ (where X is a CH_3 group, Y a carbon atom, W a CH group, and Z a large mass representing the remainder of the molecule), satisfactory agreement between observed and calculated frequencies is obtained. The implications of these results in the more general problem of the interpretation of the vibration spectra of hydrocarbons is considered. In particular, it is emphasized that such skeletal frequencies are at least partly responsible for the intense and complex absorption spectra of branched paraffins, in the interpretation of which stress has hitherto been placed mainly on the role of vibrations of the hydrogen atoms. A.

535.343.2

1650. Infra-red spectra and structure of hevea and gutta elastomers. R. A. SAUNDERS AND D. C. SMITH. *J. Appl. Phys.*, **20**, 953–65 (*Oct.*, 1949).

535.343.2 : 535.372

1651. The ultraviolet absorption and luminescence of decaborane. G. C. PIMENTEL AND K. S. PITZER. *J. Chem. Phys.*, **17**, 882–4 (*Oct.*, 1949).

The u.v. absorption spectrum of decaborane in cyclohexane shows a broad absorption with a max. molecular extinction coeff. of 3 200 ± 100 Å at wavelength 2 720 ± 50 Å. The luminescence of decaborane dissolved in a glass of 77°K shows a continuous fluorescence extending from 3 630 ± 50 Å to about 6 000 Å with a broad maximum at 4 520 Å. No further luminescence was observed at wavelengths $< 9\,000$ Å. The $0 - 0$ transition is located at 3 600 ± 50 Å. The energy levels of a particle in a rectangular, hemispherical, and spherical box were used to test the applicability of a metallic model to decaborane. Agreement with the absorption spectrum and the molecular dimensions was obtained. A.

535.343.3

1652. Infrared absorption spectra of cyclo-hydrocarbons. E. K. PLYLER AND N. ACQUISTA. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 37–48 (*July*, 1949).

The infrared absorption spectra of 19 hydrocarbons have been measured in the 3·4-micron region, and the location of the two CH_2 vibrations has been determined. A.

535.343.3

1653. Rotational absorption spectrum of HDO. M. W. P. STRANDBERG. *J. Chem. Phys.*, **17**, 901–4 (*Oct.*, 1949).

The $2_2 - 2_1$, $3_0 - 3_1$, $4_{-3} - 3_1$ and the $5_0 - 5_1$ rotational absorption transitions of HDO have been observed and identified on the basis of their Stark effect. By comparing the theoretical and experimental Stark shift, the dipole moment for all these transitions has been measured as 1·84 ± 0·01. The effective HOD angle is also determined as 104° ± 30′ and the parameter of asymmetry, κ, as about − 0·696.

The line breadth $\Delta\nu$ at one atm. is $0{\cdot}38 \pm 0{\cdot}04$ cm^{-1}. None of these quantities is in disagreement with independent determinations. A.

535.343.3

1654. Infrared absorption spectra of the liquid butenes and 1,3-butadiene. E. C. CREITZ AND F. A. SMITH. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 365–75 (*Oct.*, 1949).

535.343.32–31

1655. Ultraviolet absorption of fluorinated aromatic hydrocarbons. C. H. MILLER AND H. W. THOMPSON. Letter in *J. Chem. Phys.*, **17**, 845–6 (*Sept.*, 1949).

535.343.4

1656. The absorption of gaseous HCl, HBr and HI in the Schumann region. J. ROMAND. *Ann. Phys., Paris*, **4**, 527–92 (*Sept.–Oct.*, 1949) *In French.*

Full experimental details of the spectrophotographic determination of extinction coeff. in the Schumann region up to the LiF absorption limit are given. The results obtained for HCl, HBr and HI have already been briefly reported. [See Abstr. 2083, 3686 (1948)]. R. F. BARROW

535.343.4

1657. Inversion frequency of ammonia and molecular interaction. H. MARGENAU. *Phys. Rev.*, **76**, 1423–9 (*Nov.* 15, 1949).

Several experiments on the shape and position of the inversion lines of NH_3 have indicated an effective decrease in the inversion frequency with increasing pressure of the gas. As suggested in a former paper (Abstr. 6901 (1949)], this is to be expected on theoretical grounds. It is here shown, first with the use of a simple linear model, that the interaction of two NH_3 molecules causes the doublet levels to change their spacing in a manner which produces 2 possible transitions of different frequencies, one $<$ and one $>$ the normal value. When transition probabilities are calculated it is seen that the smaller frequency gains in strength upon approach of the molecules, at the expense of the other. The effect of rotation upon the distortion of the levels is calculated, and a schematic calculation of the interaction of 3 molecules is given. The pressure for which the reduction in the resonance frequency is experimentally observed agrees surprisingly well with the distance of separation between molecules at which the effect here calculated sets in. A.

535.343.4

1658. The infra-red absorption spectra of some metal borohydrides. W. C. PRICE. *J. Chem. Phys.*, **17**, 1044–52 (*Nov.*, 1949).

The absorption spectra of Al, Li and Na borohydride have been obtained in the region from 1–25 μ. A.

535.343.4

1659. Rotation-vibration spectra of diatomic and simple polyatomic molecules with long absorbing paths. II. The spectrum of carbon monoxide below 1.2μ. G. HERZBERG AND K. NARAHARI RAO. *J. Chem. Phys.*, **17**, 1099–1101 (*Nov.*, 1949).

The third overtone of CO at $1{\cdot}19\,\mu$ has been photographed under high dispersion. From this band precise values for the rotational constants of the CO molecule are derived. They agree excellen with the values obtained from the u.v. spectra b are considered to be much more accurate. T equilibrium internuclear distance of CO in t ground state is $r_e = 1{\cdot}1281_9 \times 10^{-8}$ cm. An atten to obtain also the fourth overtone failed even w path lengths of 3 000 m atmos. The second overto was observed under low resolution with a pa length of 30 m.

535.343

1660. The ν_3-fundamental of nitrous oxide. K. RHODES AND E. E. BELL. *Phys. Rev.*, **76**, 12 (*Oct.* 15, 1949).

535.343.4 : 536.

1661. Ultra-violet absorption spectra of rubidiu and caesium fluorides and the heat of dissociation fluorine. A. D. CAUNT AND R. F. BARROW. Lett in *Nature, Lond.*, **164**, 753–4 (*Oct.* 29, 1949).

The heats of dissociation of the gaseous fluorid at 18°c are found to be: 126·1 or 124·9 kcal f RbF; 130·7 or 129·5 for CsF, where the high figures are for dissociation into $F(^2P_{\frac{3}{2}})$, the low into $F(^2P_{\frac{1}{2}})$. Combining these with thermochemic data, the heat of dissociation of F_2 is found to b 50 $\pm$ 6 kcal at 18° c. [Abstr. 573 (1948), 1000 (1949)] R. F. BARRO

535.3

1662. A proof of the associated-pair theory fo sensitized luminophors. F. A. KRÖGER. *Physica*, 1 801–6 (*Sept.*, 1949).

For $Ca_3(PO_4)_2$ and $Sr_3(PO_4)_2$ containing Mn as a activator and Sn or C as a sensitizer the spectra distribution of the Mn fluorescence, the temp dependence of its intensity and the temp.-dependenc of its decay have been measured. Analysis of th experimental data leads to figures for the transitio probabilities of the fluorescence process and th dissipation process in the Mn centres. Comparison shows that these quantities are markedly differen for the centres in products containing Sn and Ce a sensitizers. This proves that the sensitizer atom must be close to the activator atoms as was assume in the associated-pair-theory of sensitization. A

535.37

1663. Absolute efficiency of luminophors under excitation with α-rays, γ-rays and white X-rays I. BROSER, H. KALLMAN AND U. M. MARTIUS. *Z Naturforschung*, **4a**, 204–17 (*June*, 1949) *In German.*

Measurements with a calibrated photomultiplier show marked differences with different types of phosphors and different excitations. ZnS with α-rays is most efficient, reaching 25%, while organic materials convert only a small fraction. γ-rays are least efficient in all cases. A theoretical discussion is attempted. J. EWLES

535.371

1664. Energy transfer in tungstates and molybdates activated with samarium. T. P. J. BOTDEN AND F. A. KRÖGER. *Physica*, **15**, 747–68 (*Sept.*, 1949).

535.371

1665. Triplet-singlet transitions in organic molecules. Lifetime measurements of the triplet state. D. S. MCCLURE. *J. Chem. Phys.*, **17**, 905–13 (*Oct.*, 1949).

535.371

1666. Light mission of europium. K. PRZIBRAM. *Acta Phys. Austriaca*, **3** (*No.* 1) 126–9 (1949) *In German.*

[See Abstr. 2428 (1948)]. A table showing the band maxima of Eu in different hosts under different conditions of preparation is given. The appearance of the blue band does not require a reducing atmosphere in the preparation. J. EWLES

535.371

1667. Investigations of luminescence phenomena on manufactured silicon carbide. H. TETZNER. *Z. angew. Phys.*, **1**, 153–61 (*Sept.*, 1948) *In German.*

Various forms of luminescence are observed during the passage of currents through impure SiC crystals. Their appearance depends on the polarity of the applied voltages. When SiC is the cathode, luminescence occurs over a small area surrounding the metal electrode, and appears to be located just below the glassy surface. Probe measurements show this region to be well conducting. When SiC is the anode, blue or green luminescence appears in the form of irregularly distributed pin-heads. Anodic luminescence requires higher voltages. Electrolytes can be used as an alternative to metal electrodes. It is considered that the mechanism of cathodic luminescence is similar to that of normal phosphors, except that luminescent centres are replaced by larger "luminescent domains." This process is thus expected to depend on impurity content and its absence in chemically pure SiC has been confirmed. Neither form of luminescence can be "frozen out" and both have a very short decay period. When a crystal is irradiated with u.v. light, the areas which fluoresce coincide with the regions of cathodic luminescence. The regions of anodic luminescence cannot be similarly excited. Anodic luminescence is thought to be a thermal effect due to highly localized power dissipation in internal spreading resistances. Some practical applications are suggested.

H. K. HENISCH

535.371

1668. Experimental investigations of the migration of energy in fluorescent solutions. S. I. VAVILOV, M. D. GALANIN AND F. M. PEKERMAN. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **13**, 18–32 (*Jan.–Feb.*, 1949) *In Russian.*

The influence of the concentration of solutions of complex organic molecules on their photoluminescence has been investigated, and a new theory has been presented to explain the concentration quenching of fluorescence. When the increase of concentration reduces the mean distance between molecules in a solution to a value smaller than the wavelength of the emitted light, inductive resonance should arise between the oscillators of the molecule that has absorbed light and those of a neighbouring molecule. Several equations have been derived for polarization, efficiency and the average duration of the excited state. The constants of the equations have been calculated from experimental data obtained with the dyes Rhodulin Orange, fluorescein, Rhodamine *B*, Rhodamine 5*G* and Acridine Orange. The theory has been verified by testing the behaviour of solutions of dyes in a specially prepared porous glass. The expected shift to higher concentrations was obtained. Another positive check was the observed depolarization during extinction. F. LACHMAN

535.372 : 535.343

1669. Spectroscopic properties of uranium compounds. G. H. DIEKE AND A. B. F. DUNCAN. (*National Nuclear Energy Series. Manhattan Project Tech. Section. Division V. Volume* 2) *New York, Toronto, London, McGraw-Hill Book Company, Inc.* (1949) 290 *pp.*

Spectroscopic studies of U compounds, such as fluorescence and absorption spectra, intensity measurements and effects of temp. are described. Sections are also included which deal with experimental procedures, X-ray structure analysis, techniques for synthesis and growth of uranyl compounds and miscellaneous observations. Three appendices give wavelength tables of the spectral emission lines for the fluorescence of several alkali uranyl salts, descriptions of special preparations and a note on contributions of the studies to the chemistry of U. An extensive bibliography follows together with author and subject indices. Topics of special interest included are the effects of relative isotope contents on the position of spectral lines, line splitting in magnetic fields and the effect of temp. on emission spectra over a range from 14°K to 273°K. Other investigations reported include studies of the effects of impurities on spectra and the relative sharpness of emission lines due directly to impurities, the effect of lattice substitution in alkali uranyl nitrates and the photochemical activity of U compounds.

G. F. J. GARLICK

535.375.5

1670. Raman spectrum of crystals of hydrated nitrates. J.-P. MATHIEU. *C.R. Acad. Sci., Paris*, **229**, 1068–9 (*Nov.* 21, 1949) *In French.*

535.375.5

1671. Raman and infra-red spectra of β-quartz. B. D. SAKSENA AND H. NARAIN. *Proc. Indian Acad. Sci. A*, **30**, 128–39 (*Sept.*, 1949).

The frequencies fall into 6 classes A, B, C, D, E_1 and E_2, the number of frequencies in the various classes being 1, 2, 3, 2, 4 and 4 respectively. Classes E_1 and E_2 are doubly degenerate. Of the 4 frequencies belonging to the totally symmetric class in α-quartz, namely 207, 356, 466 and 1 082, only the frequency corresponding to 466 (452·8) can persist in the totally symmetric class in β-quartz and the remaining 3 should be forbidden in the Raman and infrared spectrum. Further all the frequencies belonging to the degenerate class in α-quartz appear in the 2 degenerate classes in β-quartz. Both these facts have been observed in the Raman spectrum of β-quartz. As regards the infrared spectrum the results show that the 4 frequencies observed in α-quartz in the extraordinary ray, 2 only, namely 777 and 364 will be forbidden in β-quartz. Also of the 8 degenerate frequencies only 4 will appear in the infrared in the ordinary ray and the remaining 4 will not be active in the infrared. The i.r. spectrum has not been observed. A.

535.375.5 : 536.75

1672. The infra-red and Raman spectra and the thermodynamic properties of diborane. A. N. WEBB, J. T. NEU AND K. S. PITZER. *J. Chem. Phys.*, **17**, 1007–11 (*Nov.*, 1949).

Deuterated diborane has been prepared by isotopic exchange and its i.r. absorption spectrum measured. The Teller–Redlich product rule ratios lend support to the assignment based on the protonated double bond or bridge model. Redetermination of the Raman spectrum of normal diborane indicates several changes from previous assignments. The resulting vibrational assignment was used to calculate the thermodynamic properties of diborane in the range 100–1 500°K. A.

535.375.5

1673. The constant frequency Raman lines of N-paraffins. T. SIMANOUTI AND S. MIZUSHIMA. *J. Chem. Phys.*, **17**, 1102–6 (*Nov.*, 1949).

535.376

1674. The coefficient of efficiency in the β-ray excitation of zinc-sulphide luminescence. G. I. BORN, N. RIL AND K. G. ZIMMER. *Dokl. Akad. Nauk, SSSR*, **59** (*No.* 7) 1269–72 (1948) *In Russian.*

535.39

1675. Study of some optical properties of thin films. M. PERROT. *Rev. Opt.* (*Théor. Instrum.*) **28**, 564–8 (*Oct.*, 1949) *In French.*

The analysis of elliptically polarized light reflected by a thin film enables the indices of refraction ν and of extinction κ to be determined as a function of film thickness d. The latter is usually determined by weighing, it being assumed that the density is the same as in the solid state. This is not always true—examples are given. Details are given of some optical properties which enable ν and d to be obtained directly from a measurement of the reflection factors when $\kappa \sim 0$. It is essential that the conditions of preparation of the layers and the surfaces upon which they are deposited be well defined. A brief description is given of an apparatus suitable for the above determination and the precautions necessary to ensure correct deposition of the layers are mentioned. [See Abstr. 136 (1932), 4226 (1934), 101 (1948)]. H. G. JERRARD

535.39

1676. On the structure and optical properties of thin metallic films. N. CABRERA AND J. TERRIEN. *Rev. Opt.* (*Théor. Instrum.*) **28**, 635–43 (*Nov.*, 1949) *In French.*

Thin films may be continuous, or contain holes, or consist of separate grains. Thermodynamic theory [Cabrera, Abstr. 161 (1947)] indicates the stability of these forms. Values of refractive index and extinction coeff. calculated by Krautkramer [Abstr. 3648 (1938)] from measurements on Ag and Au films give consistent values down to 12 $m\mu$ thickness. It is presumed that thinner films are discontinuous, the structure causing loss of light by diffusion and increased extinction coeff. of the grains; possible methods for theoretical treatment of such films are indicated. Stabilization of continuous films by artificial surface oxidation is suggested.

G. F. LOTHIAN

535.

1677. The formulation of a general diffracti problem by means of an integral equation. A.- MAUE. *Z. Phys.*, **126** (*Nos* 7–9) 601–18 (1949) *German.*

The equation gives the values of the solution Kirchhoff's equation on the surface of a diffracti body. In the case of electromagnetic waves, t equation gives the surface current of an ideal conducting body. The modifications required deal with sharp bends, and the diffraction by bound surfaces are discussed. The treatment is applied the diffraction by a cylinder. E. P. WOHLFART

535.4

1678. Complementary diffraction problems. A.-V MAUE. *Z. Naturforsch.*, **4a**, 393–4 (*Aug.*, 1949) *German.*

Babinet's principle is formulated generally fo scalar and electromagnetic waves incident on plan surfaces. E. P. WOHLFART

535.42

1679. Direct demonstration on the Fresnel formula for diffraction of a plane wave by a reflecting half-plan J. BRILLOUIN. *C.R. Acad. Sci., Paris*, **229**, 513–1 (*Sept.* 5, 1949) *In French.*

By transforming Laplace's equation into sem parabolic co-ordinates it is shown that the electro magnetic treatment of diffraction leads to the sam results as Fresnel's treatment. N. CORCORA

535.4

1680. A note on the scattering of light in plastics V. P. NARAYANAN NAMBIYAR. Letter in *Curr. Sci.* **18**, 286–7 (*Aug.*, 1949).

Details are given of scattering in perspex. Th results suggest that the scattered light is strongl polarized and that molecular aggregates exist whic are approximately the same size as those in optica glasses. H. G. JERRARD

535.43 : 538.6

Contributions to the theory of diffraction of electro magnetic waves by spherical particles. II. *See Abstr.* 1882

535.434

1681. Comparison of the Rayleigh–Mie dispersion theory with the theory of the Plotnikow effect. T. NEUGEBAUER. *Hungar. Acta Phys.*, **1** (*No.* 4) 39–43 (1949) *In German.*

It is not possible to explain the Plotnikow effect [Neugebauer, *Phys. Zeit.*, **41**, 55 (1940); **44**, 233 (1943)] on the basis of the Rayleigh–Mie theory.

R. F. BARROW

535.434 : 541.135.85

1682. Light scattering by charged particles in electrolyte solutions. J. J HERMANS. *Rec. Trav. Chim. Pays-Bas*, **68**, 859–70 (*Nov.*, 1949).

It is easy to show that the concentrations of the ions in an electrolytic solution do not fluctuate independently. For this reason the theory of fluctuations does not represent an adequate approach to the problem of light scattering by electrolytes. The formulae obtained from distribution functions are discussed. It is assumed in most of the treatment that a colloid particle with its double layer can be regarded as a separate unit. On this basis formulae

are developed for compact spherical particles and random coils. A.

535.434 : 541.64

1683. Light-scattering apparatus and techniques for measuring molecular weights of high polymers. H. J. HADOW, H. SHEFFER AND J. C. HYDE. *Canad. J. Res. B*, **27**, 791–806 (*Oct.*, 1949).

Apparatus is described for the measurement of small amounts of scattered light, dissymmetry of radiation, depolarization and very small refractive index differences. Methods of calibration are critically examined. Benzene was adopted as a turbidity standard. Measurements were made on fractionated polystyrene of known molecular weight and on bovine serum albumin solutions. Degree and sources of error are discussed. A.

535.435

1684. The influence of exchange effects between molecules on bremsstrahlung in classical theory of light dispersion. YU. L. KLIMONTOVICH AND V. S. FURSOV. *J. Exp. Theor. Phys., USSR*, **19**, 819–25 (*Sept.*, 1949) *In Russian.*

The bremsstrahlung term has been shown to disappear from the equation of motion of an electron in a crystal and to have Planck's form in the case of an ideal gas. In a real gas it depends on relative spacings of molecules, which are related to their exchange forces. Spherically symmetrical molecules with no permanent dipole moment are assumed; the field due to an induced dipole moment p around a molecule acts also on others distant $< \lambda$, the wavelength of incoming light. The field due to one oscillator depends on the third time derivative of p, not on the distance from the oscillator. The relation between polarization and electric field contains $(\nu - n)$; [ν = no. of particles in elemental sphere centre at molecule, n the same with arbitrary centre]. ν and n are found from statistical mechanics. Hence dependence of bremsstrahlung term in classical dispersion and absorption theory on thermodynamic parameters is established. J. JACOBS

535.542.1

1685. Berek's compensater. P. R. J. NAIDU. Letter in *Curr. Sci.*, **18**, 289–90 (*Aug.*, 1949).

A numerical formula for the optical path difference for the ordinary and extraordinary rays through a calcite prism is derived for different angles of incidence. Neglecting $\sin^6 i$, the path difference is $\propto$

$$\sin^2 i(1 + 0{\cdot}2040 \sin^2 i + 0{\cdot}0627 \sin^4 i),$$

Formulae are given for evaluation of the numerical coeffs. in terms of the refractive indices.

N. CORCORAN

535.55

1686. Determination of the isopachics (lines of equal total principal stress) in stress optics. R. LANDWEHR AND A. DOSE. *Naturwissenschaften*, **36** (*No.* 11) 342–3 (1949) *In German.*

An interference method is briefly described.

H. G. JERRARD

535.563

1687. Polarimetry in the ultra-violet region and its chief results. R. SERVANT. *Rev. Opt.* (*Théor. Instrum.*) **28**, 560–3 (*Oct.*, 1949) *In French.*

Brief details are given of a method used in the Schumann region of the u.v. in which measurements of birefringence and rotatory power are obtained. The variation is considerable in the neighbourhood of the absorption bands. Graphs are shown of the variation of birefringence with wavelength for barytes and gypsum. The birefringence of barytes in the u.v. is $> 6\times$ its value in the visible region. For quartz the birefringence increase at 1 000 Å is 200 times more rapid than in the visible region and at the same wavelength its rotatory power is $15\times$ its value in the red. These data are useful for a general discussion of the properties in the whole of the spectral region and reference is made to formulae for the rotation and birefringence of quartz previously mentioned by same author. [See *C.R. Acad. Sci., Paris*, **211**, 641 (1940); **212**, 1140 (1941). *J. Phys. Radium*, **3**, 90 (1942); **4**, 105 (1943); and Abstr. 2823 (1926), 3241 (1934), 4031 (1939), 1147 (1940)]. H. G. JERRARD

535.563 : 535.58 : 538.613

1688. Production of intense magnetic fields by impulses. Application to phenomena of rotary polarization and magnetic birefringence. G. RAOULT. *Ann. Phys., Paris* (*Sér.* 12) **4**, 369–421 (*July–Aug.*, 1949) *In French.*

Numerous methods for producing intense magnetic fields are briefly reviewed, and from these is chosen the method of discharge of an electrical condenser through a coil. The theory is supplied for the nature of the discharge and the calculation of coil shape and size. Magnetic fields up to 52 000 oersted of 15 μsec duration are attained at the rate of 100 times per sec by this method. A light source (duration $\simeq 1$ μsec) is excited 50 times per sec simultaneously with the peak fields. A study is made of the spectrum emitted by Hg vapour contained in a tube in which impulses of short duration are produced: a high order spectrum is easily obtained. The magnetic field strength is measured by the rotatory polarization produced in CS_2. Experimental results, obtained on the dispersion of the rotatory polarization in CS_2 in the u.v. region (*c.* 2 700 Å) using a photoelectric polarimeter of the Bruhat type, are plotted as a curve of Verdet constant against wavelength. It is similar to the curve obtained by plotting refractive index against wavelength as found by Bruhat and Parthenier. Finally a study of the magnetic birefringence in CS_2 is made in the same region of the u.v. and comparison made with the corresponding electric birefringence A formula is given to represent the dispersion in the neighbourhood of the absorption band.

H. G. JERRARD

535.566.2

1689. Internal rotation. IV. The optical activity and isomerization energy of the rotational isomers of *D*-secondary butyl alcohol. H. J. BERNSTEIN AND E. E. PEDERSEN. *J. Chem. Phys.*, **17**, 885–91 (*Oct.*, 1949).

535.568.1

1690. Photographic spectropolarimetry with an arrangement using an objective of large aperture. R. SERVANT. *Rev. Opt.* (*Théor. Instrum.*) **28**, 558–60 (*Oct.*, 1949) *In French.*

Consideration of the errors in photographic polarimetry shows that the intensity of the source or the time of exposure should be large. Since the latter

is often required to be small, especially in magneto-optic measurements, an increase in intensity is necessary for high sensitivity. A description is given of an experimental arrangement using a spectrograph with a large aperture ($f/1 \cdot 9$) which is suitable for the visible and near u.v. regions. The photographs taken are examined with a microphotometer and in this way a high sensitivity is possible with a time of exposure of only a fraction of a second. Results are given for the rotatory dispersion of limonene over a wavelength range 3 665 to 5 893 Å. [See Bruhat and Pauthenier, *ibid.*, **6**, 163–84 (*April*, 1927)].

H. G. JERRARD

535.65

1691. Shape irregularities in the equal energy luminosity curve. L. C. THOMSON. *Proc. Phys. Soc. B*, **62**, 787–92 (*Dec.*, 1949).

The photopic luminosity function of two observers with normal colour vision has been measured. Two shoulders on the curve in the blue region of the spectrum first noticed by Gibson and Tyndall have been confirmed, and the relationship of the curves to the standard C.I.E. luminosity function is discussed.

A.

535.65

1692. A comparison of direct colorimetry of titanium pigments with their indirect colorimetry based on spectrophotometry and a standard observer. D. B. JUDD. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 227–36 (*Sept.*, 1949).

535.65 : 778.6

1693. Progress in the field of evaluation of colorimetric stimuli. E. HELLMIG. *Z. wiss. Photogr.*, **44**, 58–76 (1949) *In German.*

The method of "selected ordinates" is generalized and its limitations pointed out. Another method based on harmonic analysis is given: the evaluation of the stimuli consists essentially in the calculation of a rapidly converging series of the products of corresponding Fourier coeffs. of two values characteristic of the pigment. The new are compared with previous methods, and found to save time. Graphs and tables are given.

R. A. WEALE

535.66

1694. The colors of natural objects and terrains, and their relation to visual color deficiency. C. D. HENDLEY AND S. HECHT. *J. Opt. Soc. Amer.*, **39**, 870–3 (*Oct.*, 1949).

535.7 : 612.84

1695. On the optical properties of the crystalline lens. A. IVANOFF. *J. Phys. Radium*, **10**, 330–3 (*Nov.*, 1949) *In French.*

The crystalline lens is shown to consist of two regions: (*a*) the central whose approximate diameter is 1 mm, and where spherical aberration is marked and varies with the state of accommodation of the eye; (*b*) the peripheral region which forms an almost perfectly stigmatic lens whose refractive index varies according to the law $n = n_0 - 0 \cdot 002\, h^2$, where h is the radial distance. The "best" image (the one formed on the retina) nearly coincides with that formed by the peripheral rays. The focusing properties of the crystalline lens are determined much more by the radial variation of its refractive index than by its curvature. This is shown by an experiment on a rabbit's lens, forced between two parallel plates of glass: the measured convergence corresponds to 25 diopters as compared with a calculated value of 22. The spherical aberration of the central part is obnoxious only at high brightnesses or high accommodation.

R. A. WEALE

535.7 : 621.385.83

1696. Visibility on cathode-ray tube screens: viewing angle. S. B. WILLIAMS. *J. Opt. Soc. Amer.*, **39**, 782–5 (*Sept.*, 1949).

Thresholds of visual detectability were determined for signals on a modified 7BP7 c.r.t. Thresholds were determined in units of signal voltage for 3 "pip" sizes, all small, and for 4 screen brightnesses at each of several positions from the line of binocular regard to 20 degrees out from it. The purpose was to determine the limits within which chance eccentricity of view could be a factor in radar detection. The range of impairment from 0 to 20° of eccentricity was ~ 17 db of signal voltage. The course of the impairment is probably not quite linear, with the optimal scope brightness (~ 0·16 footlambert for this phosphor), but the slope is a function of scope brightness. For very small pips the data show no region of equal visibility, even within the fovea; direct fixation is required for maximal detection. There being no data based on optically precise stimuli available for comparison with the radar thresholds, an estimate was made of the luminances of the pips and their backgrounds. As estimated, the visual threshold probably varies up to one-log unit or greater over a range of 20° of viewing angle, for the optimal scope background.

A.

535.833

1697. Relation between entrance and exit pupils of telescopic systems. I. C. GARDNER. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 157–60 (*Aug.*, 1949).

The definitions of the entrance and exit pupils, as commonly given, are formulated in terms of paraxial imagery only. For telescopic systems the definitions have been extended to apply to extra-axial points and to include the effects of pupil aberrations. If a telescopic system is free from distortion and an incident plane wave emerges as a plane wave free from aberrations, it is shown that exact relations between conjugate chords in the entrance and exit pupils can be derived by application of principles of the wave theory. These results are applied to give the variation in theoretical resolving power over the field of a telescopic system. Equivalent relations are derived by equating the flux of energy in the incident beam to that in the emergent beam. A relation between the illuminations of the object and image planes is derived.

A.

535.833

1698. Focusing errors in telescopes having negative lens focusing. P. VINCENT. *Rev. Opt.* (*Théor. Instrum.*) **28**, 548–57 (*Oct.*, 1949) *In French.*

If the optical centre of the internal focusing lens moves such that it departs from the optical axis of the telescope, both longitudinal and lateral errors of focusing generally appear. Formulae are given for these errors in the cases of: (*a*) movement along a

traight line other than the optical axis; (*b*) movement long the axis presenting a small local error which isplaces the lens laterally; (*c*) curvilinear movement case considered is the arc of a circle). The formulae re adapted to different methods of initial error- minimizing adjustment. They are illustrated by a numerical example. The use of the formulae is proposed in devising manufacturing tolerances for precision levels, theodolites and tacheometers.

H. H. HOPKINS

HEAT 536

536.2.08

1699. A method of measuring the thermal conductivity of liquids. E. F. M. VAN DER HELD AND F. G. VAN DRUNEN. *Physica*, **15**, 865–81 (*Oct.*, 1949).

The apparatus described is suitable for all kinds of liquids, including the strongest acids. An electric current is passed for a given time through a thin straight wire, placed in a homogeneous material of which the thermal conductivity is to be measured. A.

536.212.2 : 537.312.62

1700. The thermal conductivity of lead and tin in the superconducting and in the normal state. A. RADEMAKERS. *Physica*, **15**, 849–59 (*Oct.*, 1949).

A metal in the superconducting state shows a smaller thermal conductivity than the same metal in the normal state and at the same temp. Pure samples of the metals Pb and Sn have been examined in this respect at temps. between 1·4 and 4°K. The results are compared with the theory of Heisenberg. A.

536.212.3

1701. Boundary conditions of the method of the "regular regime." M. F. KAZANSKIĬ. *J. Tech. Phys., USSR*, **19**, 743–8 (*June*, 1949) *In Russian.*

This is a method of investigating the thermal conductivity of badly conducting materials. The author investigates the influence of the imperfect fulfilment and maintenance of the boundary conditions on the experimental results and derives correction formulae. The experimental set-up is described and tabulated and graphed results are given demonstrating the usefulness of the method.

B. F. KRAUS

536.23

1702. Experimental determination of heat conductivity for gases. F. G. KEYES. *Trans. Amer. Soc. Mech. Engrs*, **71**, 939 (*Nov.*, 1949).

Short account of experimental methods and results.

536.24 : 532.5 : 518.5

Application of electric-analog computers to heat-transfer and fluid-flow problems. *See Abstr.* 1381

536.25 : 532.52

Convection currents in porous media. *See Abstr.* 1539

536.42

1703. A theory of vapor pressures of liquids based on van der Waals' equation of state. II. Binary mixtures. F. T. WALL AND G. S. STENT. *J. Chem. Phys.*, **17**, 1112–16 (*Nov.*, 1949).

An expression for vapour pressures of binary liquid systems obeying van der Waals' equation of state is developed by generalizing a recent theory [Abstr. 3306 (1948)] of vapour pressures of pure liquids. The resulting partial vapour pressure equations involve composition and temp., and contain no empirical quantities other than van der Waals' constants including an inter-species interaction term. The conditions under which Raoult's law holds for these systems are formulated, together with the conditions for which positive or negative deviations occur. The compositions at which azeotropes form are predicted, and the partial miscibility of binary liquid systems is discussed. A number of examples is calculated to illustrate the theory. A.

536.421.4

1704. Dependence of rate of growth of an ice layer on air temperature and wind velocity. K. NEUMANN. *Naturwissenschaften*, **36** (*No.* 8) 249–50 (1949) *In German.*

Expressions are obtained for the upper and lower limits of the ice thickness in terms of the temp. and speed of the air and the density, specific heat, thermal conductivity and latent heat of fusion of ice, and to a close approximation these can be further simplified. Tests were made of the expressions for air temps. −10° to −22·5°C and wind velocities 0 to 6 m/s. The experimental values were also shown to give a satisfactory agreement with the Prandtl–Nusselt theory of heat flow from considerations of the latent heat of vaporization. R. S. READ

536.46 : 541.126

1705. Spectroscopic investigation of the carbon monoxide–oxygen reaction. G. A. HORNBECK AND H. S. HOPFIELD. *J. Chem. Phys.*, **17**, 982–7 (*Oct.*, 1949).

High dispersion spectrograms of CO-oxygen explosions in a spherical vessel have been obtained. Under conditions affording max. contrast between the banded spectrum and the continuum, the $^3\Sigma_u^- - {}^3\Sigma_g^-$ and the $^1\Sigma_g^+ - {}^3\Sigma_g^-$ transitions of the neutral O molecule have been observed in emission. Additional spectroscopic information on the absorption by OH radicals in flames has been obtained. A.

536.46 : 541.127

1706. The flame-speed in steady-burning flames. I–III. E. BARTHOLOMÉ. *Naturwissenschaften*, **36** (*No.* 6) 171–5 (1949) *In German.*

A modified form of the Gouy method of determining flame-speed is described. The gas-mixture burns at the orifice of a convergent nozzle, where the gas-velocity is more uniform than at the end of the cylindrical tube generally used. The dependence of the flame-speed of various fuels (mainly hydrocarbons) upon such factors as octane number, anti-knock additives and preheating was investigated. Flame-speed depends neither upon octane-number nor the knock-characteristics of the fuel, and does not increase rapidly with preheating temp. In a typical case, an increase of temp. from 0°C to 1 000°C only trebles the flame-speed. At low flame-temps., flame-speed depends mainly on flame-temp.; at high flame-temps. dissociation of the products of combustion becomes important, and H-atom concentration markedly affects flame-speed. A. SCHOFIELD

536.46 : 541.127

1707. The flame-speed in steady-burning flames. IV. E. BARTHOLOMÉ. *Naturwissenschaften*, **36** (*No.* 7) 206–13 (1949) *In German.*

From experimental results given previously (preceding Abstr.) it is concluded that flames may be divided into 2 classes: the low-temp. class, in which energy transport is mainly by thermal conductivity; and the high-temp. class, in which H-atom diffusion contributes greatly to energy-transport, and may also catalyse reactions in the flame-front. A one-dimensional theory of low-temp. thermal flames is given. The reaction zone is divided into a pre-ignition region and a post-ignition region, the assumption being made that the ignition temp. is not greatly different from the final flame-temp. Separate formal solutions are obtained for the variation of temp. with distance in these 2 regions. A parameter occurring in each solution is an assumed flame-speed; the actual flame-speed is taken to be that for which the 2 types of solution join smoothly. An expression for flame-speed is derived which is similar in form to that of Nusselt, but differs in that the reaction velocity is not arbitrarily chosen, but is directly related to the heat of activation of the reaction. A. SCHOFIELD

536.48

1708. Low temperature physics. K. MENDELSSOHN. *Rep. Phys. Soc. Progr. Phys.*, **12**, 270–90 (1948–49).

This report covers recent advances in low temperature technique, superconductivity and the superfluid properties of He. Over 116 references.

H. LONDON

536.48

1709. Heat flow in metals below 1°K and a new method for magnetic cooling. C. V. HEER AND J. G. DAUNT. Letter in *Phys. Rev.*, **76**, 854–5 (*Sept.* 15, 1949).

Measurements of the thermal conductivity K of Sn and Ta between 0·2 and 1·0°K both in the superconductive state (s) and with superconductivity destroyed by a mag. field (n). It was found that $K_s/K_n \simeq (T/T_c)^2$, where T_c = critical temp. For Sn $K_s = 1{\cdot}1 \times 10^{-2} T^3$ watt units. This behaviour will have many useful practical applications, e.g. in two stage mag. cooling, as at low temps K_s/K_n becomes so small that a superconductor provides a "thermal switch" which can be made and broken by applying and removing a mag. field. This was demonstrated by measuring the warming-up curve of a 3 cm³ CrK alum ellipsoid which was connected to a He bath at 1·13°K through 56 cm of 0·017 cm dia. Ta wire, with a transverse mag. field of 600 gauss temporarily switched on. This wire was also used for making contact with the He bath prior to demagnetization. It was therefore possible to dispense with the usual exchange gas. H. LONDON

536.48

1710. Addendum: Heat flow in metals below 1°K and a new method of magnetic cooling. J. G. DAUNT AND C. V. HEER. Letter in *Phys. Rev.*, **76**, 985–6 (*Oct.* 1, 1949).

On the basis of the preceding Abstr. a reciprocating heat pump is proposed which transfers 10^5 ergs/min from a reservoir B at 0·1°K to a reservoir A at 1°K. This would involve the use of about 10 cm³ of para-magnetic salt, which is alternately brought into thermal contact with A and B by applying mag. field to two connecting superconducting wires, while the salt is magnetized and demagnetized. H. LONDON

536.4

1711. Approximate densities of liquid He³ between 1·27° and 2·79°K. E. R. GRILLY, E. F. HAMMEL AND S. G. SYDORIAK. Letter in *Phys. Rev.*, **75**, 1103–(*April* 1, 1949).

The difference of the densities of liquid and saturated vapour was measured. Assuming a critical density of 0·042 by averaging between values resulting from either van der Waals' or Dieterici's equation of state, and ideal gas density for the vapour at 1·27°K [Abstr. 2472 (1949)], the densities of the coexistent liquid and vapour between 1°K and 3·34° are calculated. Below 1·5°K the density of the liquid is 0·0792. The latent heat of vaporization is calculated by means of the Clapeyron equation. This has a smooth maximum of about 4·6 cal/gram at 2°K, but the accuracy of this result is considered to be low.

H. LONDON

536.48

1712. Second sound velocity in paramagnetically cooled liquid helium II. J. R. PELLAM AND R. B. SCOTT. Letter in *Phys. Rev.*, **76**, 869–70 (*Sept.* 15, 1949).

A marked increase of the second sound velocity v_2 with decreasing temp. was observed below 1°K. At the lowest temp. reached (roughly estimated $\simeq 0{\cdot}3$–$0{\cdot}4$°K) $v_2 = 33{\cdot}9$ m/sec. An increase of pulse width at the lowest temps. suggests either frequency dispersion or partial return to classical heat flow. The minimum of $v_2 = 18{\cdot}4$ m/sec just above 1°K previously reported by Peshkov [Abstr. 2474 (1949)] was confirmed. It is concluded that the phonons do not participate in superfluid flow. This is in accordance with Landau's assumptions, whereas Tisza's hydrodynamics will have to be modified in this respect. H. LONDON

536.48

1713. Second sound and classical heat flow. J. R. PELLAM. Letter in *Phys. Rev.*, **76**, 872–3 (*Sept.* 15, 1949).

These are discussed on the example of a square pulse. In He II the heat flow is $\dot{H} = \rho c_v \tau v_2$, where ρ = density and c_v = specific heat per gram of He, τ the instantaneous temp. rise and v_2 the second sound velocity. Linked with this is the mechanical energy generation or intensity $\gamma = \dot{H}\tau/T_0$, where T_0 is the ambient temp. This expression is equally significant in classical heat flow. On the boundary between He II and a classical medium one has, for normally incident second sound the law $\gamma_i - \gamma_r = \gamma_{tr}$ where the suffixes refer to the incident, reflected and transmitted wave. $\dot{H}$ and τ are related to each other by the impedance $\tau/\dot{H}$, which equals $(\rho c_v v_2)^{-1}$ for He II, where it is entirely real, whereas in a solid it may have an imaginary component as large as the real component. Some speculations are made about the final dissipation of γ in the classical medium.

H. LONDON

536.48

1714. Measurements concerning the vapor-liquid equilibrium of solutions of He^3 in He^4 below 2·19°K. K. W. TACONIS, J. J. M. BEENAKKER, A. O. NIER AND L. T. ALDRICH. Letter in *Phys. Rev.*, **75**, 1966 (*June* 15, 1949).

Measurements of the difference in vapour pressure p between He containing He^3 at concentrations from 5×10^{-4} to 35×10^{-4} and normal He. At 1·75°K p ranges from 0·16 to 1·11 mm Hg. The results are discussed by assuming ideal gas law and ideal solution, but considering liquid He II as a two-fluid system with He^3 soluble in the normal fluid only. This leads to expressions for the partial pressures of He^3 and He^4 which are consistent with the experiments. H. LONDON

536.48

1715. Measurements concerning the vapour-liquid equilibrium of solutions of He^3 in He^4 below 2·19°K. K. W. TACONIS, J. J. M. BEENAKKER, A. O. C. NIER AND L. T. ALDRICH. *Physica*, **15**, 733–9 (*Sept.*, 1949).

From vapour pressure measurements of a known quantity condensed mixture of He^3 and He^4 (concentration of He^3 5×10^{-4}) in a vessel of 0·33 cm³ the concentrations of He^3 in the liquid and vapour phase were calculated assuming: (*a*) perfect solubility of He^3 in the "normal" helium fluid only, (*b*) a perfect gas in the vapour phase, and (*c*) that the equilibrium between the two fluids of the He II system is not altered by the He^3. The two concentrations together with the measured amounts of vapour and liquid in the vessel made it possible to compute the total amount of He^3 present in the vessel. This value agreed under various circumstances with the known quantity of He^3 condensed in the vessel and it was concluded that the above-mentioned assumptions are confirmed. A.

536.48

1716. Solutions of He^3 in He^4. J. W. STOUT. Letter in *Phys. Rev.*, **76**, 864–5 (*Sept.* 15, 1949).

Calculation of the change of the λ-temp. of He^3–He^4 solutions with the mole fraction x of He^3 from the general theory [Abstr. 990 (1949)] using the fugacity expressions derived by Taconis and Breenakker [Abstr. 1714 (1950)]. If one assumes that the transition remains second order, good agreement with the experiments [Abstr. 1718 (1950)] is obtained. If one assumes instead that the ratio of normal to superfluid portions of the He^4 component is independent of x the transition becomes of the first order and the slope of the $T_\lambda(x)$ curve is twice the value obtained in the first case. [See also Abstr. 1717 (1950)]. H. LONDON

536.48

1717. Statistical mechanics of mixtures of He^3 and He^4. J. DE BOER. Letter in *Phys. Rev.*, **76**, 852–3 (*Sept.* 15, 1949).

On the basis of the hypothesis of Taconis and Breenakker (perfect solution of He^3 in the normal portion of He^4) [Abstr. 1714 (1950)] and assuming that the ratio of the normal and superfluid portions of He^4 is independent of the mole fraction x of He^3, an expression of the fugacity ratio is given which is also valid for high values of x. The dependence of the λ-temp. T_λ on x is calculated. It is found that the transition becomes of first order, which has the consequence that 2 phases are formed, a normal phase which contains the greater portion of He^3 and a separate superfluid phase which at $T < \frac{1}{2}T_\lambda$ consists of nearly pure He^4. The calculation involves an extrapolation of the free energy of He I below the λ point, and the $T_\lambda(x)$ curve resulting from one of the possible assumptions agrees well with the experiments [Abstr. 1718 (1950)]. [See also Abstr. 1716 (1950)]. H. LONDON

536.48

1718. Lambda temperatures of He^3–He^4 mixtures. B. M. ABRAHAM, B. WEINSTOCK AND D. W. OSBORNE. Letter in *Phys. Rev.*, **76**, 864 (*Sept.* 15, 1949).

These were determined by measuring the flow rate and isotopic composition of He^3–He^4 mixtures flowing through a superleak. With 28·2% He^3 the λ-point is 1·56°K, with 92·1% He^3 no λ-point was detected down to 1·05°K. The measurements agree with a theoretical curve by J. W. Stout [Abstr. 1716 (1950)]. H. LONDON

536.48

1719. Rollin film rates in liquid helium. H. A. FAIRBANK AND C. T. LANE. *Phys. Rev.*, **76**, 1209–11 (*Oct.* 15, 1949).

Quantitative measurements have been made on the flow of the Rollin film out of a cylindrical vessel containing liquid He. The range of temp. studied extends from 1·34°K to the λ-point. It is found that the film transfer rate is somewhat > that observed for isothermal flow under a gravitational potential difference. Evidence is presented tending to show that the film can evaporate at temps. near those of the parent liquid. A.

536.48

1720. On the film transfer rate in helium II. R. T. WEBBER, H. A. FAIRBANK AND C. T. LANE. *Phys. Rev.*, **76**, 609–11 (*Sept.* 1, 1949).

In view of the wide disagreement between the two existing determinations of the flow rate of the Rollin film under a gravitational potential difference, the matter has been experimentally re-examined. The results are in substantial agreement with the earlier work of Daunt and Mendelssohn [*Proc. Roy. Soc. A*, **170**, 423, 439 (1939). See also Abstr. 3310 (1948)]. A.

536.48

1721. Thickness of the He II film. L. C. JACKSON AND E. G. BURGE. Letter in *Nature, Lond.*, **164**, 660–1 (*Oct.* 15, 1949).

The thickness d of He films formed on a stainless steel mirror partially immersed in liquid He was measured between 1·1°K and the λ-point for heights h above the liquid ranging from 0·15 to 1·5 cm by illuminating the mirror with plane polarized light and determining the direction of elliptical polarization of the reflected light [Abstr. 1433 (1945)]. Precautions were taken to ensure uniform temp. and absence of film flow. It was found that, for given h, d varies little with temp., increasing from a shallow minimum at 1·6°K to a maximum at 2·18°K and then decreasing to zero at the λ-point (2·186°K). For constant temp. $d \sim h^{1/z}$, where z varies from 3·5 at 1·1°K to 2·5 at 2·1°K. The absolute value of d at 1·5°K and $h = 1$ cm is provisionally given as $1\cdot9\times10^{-6}$ cm. H. LONDON

536.48

1722. Correlations in measurements on superfluidity in liquid helium II. J. R. PELLAM. Letter in *Phys. Rev.*, **76**, 158–9 (*July* 1, 1949).

A comparative summary of the papers [Abstr. 3181, 3950 (1949)] by the author and [Abstr. 2473–5 (1949)] by Peshkov. H. LONDON

536.48 : 538.224

The magnetic behaviour of copper potassium Tutton salt and manganese ammonium Tutton salt at very low temperatures. *See Abstr.* 1870

536.5.081

1723. Differences between the International Temperature Scales of 1948 and 1927. R. J. CORRUCCINI. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 133–6 (*Aug.*, 1949).

Tables and a graph are presented. A.

536.5.081.3 : 536.531

1724. An experimental study of the absolute temperature scale. X. Comparison of the scale of the platinum resistance thermometer with the scale of the nitrogen gas thermometer from 0° to 444·6°[C]: reduction of the observations. J. A. BEATTIE, M. BENEDICT, B. E. BLAISDELL AND J. KAYE. *Proc. Amer. Acad. Arts Sci.*, **77**, 255–335 (*May*, 1949).

Results of 284 comparisons of the indications of 4 standard Pt resistance thermometers with those of 2 N gas thermometers are given. These were made at 0, 25, 50, 75, 100, 150, 200, 300, 356·58 (b.p. of Hg), 400 and 444·6°C. The ice-point pressures in the gas thermometers were 1 000 (to 100°C), 750 (to 150°C), 600, 450 and 333 mm Hg approx. The details of the reduction of the observations to give the corrected pressures in the gas thermometers for each nominal temperature, and the effect of errors in the observed quantities and in the properties of the materials are discussed. There are 17 tables and a sketch of one of the gas thermometer systems. For previous papers in this series see Abstr. 1590 (1931); 1726 (1937); 1561–3 (1942). S. WEINTROUB

536.52

1725. Optical methods for the determination of flame temperatures. I. Two-color and line-reversal techniques. S. S. PENNER. *Amer. J. Phys.*, **17**, 422–9 (*Oct.*, 1949).

A general and partly historical review of the principles, advantages and limitations of the methods. Many references are given; recent developments are mentioned. A. G. GAYDON

536.532

1726. A new method for surface temperature measurement. N. SASAKI. *Mem. Coll. Sci. Univ. Kyoto, Ser. A*, **25** (*No.* 1) 37–9 (1947).

A thermoelement is used. One junction is put into contact with the surface and the temp. of the other junction adjusted until the e.m.f. is wholly or partly compensated. S. WEINTROUB

536.633 : 541.18

1727. On the specific heat of adsorbed helium. H. P. R. FREDERIKSE. *Physica*, **15**, 860–2 (*Oct.*, 1949).

Specific heats of adsorbed He are measured from 1·0°K to 2·5°K. It appears that they are strongly dependent on the thickness of the films. A.

536

1728. Heats of dissociation of carbon–hydro bonds in methane and its radicals. K. J. LAIDLER A E. J. CASEY. *J. Chem. Phys.*, **17**, 1087–91 (*Nov.*, 194

536.66 : 535.34

The heat of dissociation of fluorine. *See Abstr.* 1

THERMODYNAMICS 536.7/.8

536.

1729. The equation of state of gaseous He^3. J. V KRANENDONK, K. COMPAAN AND J. DE BOER. Let in *Phys. Rev.*, **76**, 998–9 (*Oct.* 1); erratum, *ibid.*, 17 (*Dec.* 1, 1949).

The second virial coeff. B of He^3 between 0·51 a 7·15°K is calculated using the potential fie $4\varepsilon[(\sigma/r)^{12} - (\sigma/r)^6]$ with the values of ε and σ whi fitted the second virial coeff. [Abstr. 351, 2580 (193 and the transport phenomena [*Physica*, **10**, 348 (194 of He^4. H. LONDO

536.

1730. Thermodynamical properties of argon function of density and temperature between 0° a 150°C and densities to 640 Amagat. A. MICHEL R. J. LUNBECK AND G. J. WOLKERS. *Physica*, 1 689–95 (*Sept.*, 1949).

From the compressibility isotherms of A given a previous publication [Abstr. 2458 (1948)] the valu of energy, entropy, kinetic energy, free energ enthalpy, free enthalpy and specific heats have bee calculated for integral values of temps. between and 150°c and densities up to 640 Amagat (pressur to 2 900 atm.).

536.7

1731. The miscibility of fluids and the virial inter-molecular forces. J. BRODIN. *Ann. Phys., Par* (*Sér.* 12) **4**, 422–524 (*July–Aug.*, 1949) *In French.*

The behaviour of real gases is studied by means a graphical representation obtained by plotting th metavolume ($= V - pV^2/NkT$) against $1/V$. It i shown that the thermodynamic properties of a syste may be expressed in terms of the metavolume an the limiting value as $V \to \infty$ is expressed in term of the intermolecular energy. The determination o the thermodynamic functions of mixtures is reviewe and also the equilibrium conditions. The equilibrium of a system in contact with its vapour is examine and expressions for the fugacities of the phases of 2 component system of 2 phases deduced in terms o the fugacities of the pure components. Azeotropi systems are discussed. The system methane–propan is examined numerically and the results deduce compared with those directly observed. It is show that the formulae of Gillespie and of Duhem for th fugacities are in substantial agreement for this syste The expression "isodyne" is proposed for a series o binary mixtures having the same ratio f_2/f_1 (f_1, f_2 th fugacities of the components) and the isodynes fo methane–propane systems traced. The condition of stability of a mixture and the compositions of th phases in equilibrium in the case of partial miscibilit are predicted by an extension to the isodynes o mixtures of the Thomson condition in liquefaction

inally, the theories of intermolecular energy are viewed in their applications to gases and liquids.

F. E. HOARE

536.71 : 531.19

1732. Development of probability densities in power eries of the density. J. DE BOER. *Physica*, **15**, 680–8 *Sept.*, 1949).

The configurational probability density for an rbitrary number of molecules and the kinetic energy ensity are developed in power series of the density. hese power series are substituted to give the general xpressions for the caloric and thermal equations of tate given in a previous paper [*ibid.*, **6**, 409 (1939)]. he terms $\propto$ the density are evaluated and are shown o be identical with those obtained with the partition unction method. A.

536.75

1733. Thermodynamic properties of oxygen, nitrogen, and air at low temperatures. L. C. CLAITOR AND D. B. CRAWFORD. *Trans. Amer. Soc. Mech. Engrs*, **71**, 885–95 (*Nov.*, 1949).

New temp.-entropy diagrams of suitable scale are presented for these materials. These diagrams are calculated from literature data on zero-pressure heat capacity and latent heats of vaporization, and from a reduced equation of state which was obtained from a correlation of literature data on volumes, Joule–Thomson coeffs. and velocity-of-sound measurements. A.

536.75

1734. Semi-logarithmic entropy–volume (S–log V) diagrams for interpretation of results of experiments. R. VICHNIEVSKY AND B. SALE. *Rev. Inst. Franç. Pétrole*, **3**, 319–27 (*Dec.*, 1948).

A new representation is given of the states of a gas mixture using S and log V as variables. This representation is particularly convenient for the study of the thermodynamic cycles and for indicator cards analysis. The charts take account of the specific heat variation with temp. and the dissociation equilibrium at high temps. All main thermodynamic evolutions are represented by straight lines or nearly straight lines as is shown by a mathematical discussion.

FUEL ABSTRACTS

536.75

1735. Zero-pressure thermodynamic properties of carbon dioxide. S. GRATCH. *Trans. Amer. Soc. Mech. Engrs*, **71**, 897–903 (*Nov.*, 1949).

Tables of the principal thermodynamic properties of CO_2 are presented along the zero-pressure isobar in the range 100 to 5 000°R at the intervals: 100(5)130(10)240(20)500(50)1 000(100)2 000(200)5 000. The data have been computed by the methods of quantum statistical mechanics from best available information regarding (*a*) the general physical constants, (*b*) the spectroscopic constants for CO_2, (*c*) the isotopic weights of C and O, (*d*) the relevant abundance ratios. Computational accuracy well beyond present physical accuracy has been maintained for practical reasons. It is believed that the tables given herein should supersede all previous ones. Although the estimated uncertainties of the values tabulated are still somewhat larger than those for some of the simpler molecules, they are probably small enough for most engineering applications. The calculated values are in fair agreement with those obtained from calorimetric and acoustic-velocity measurements. A.

536.75

1736. The consistency of the thermodynamic data for water substance vapor phase to 550°C. VII. F. G. KEYES. *J. Chem. Phys.*, **17**, 923–34 (*Oct.*, 1949).

A comprehensive investigation of the thermodynamic consistency of the large body of steam data above 150°C has been completed using the new thermodynamic scale information supplied by Beattie to test the consistency of measured vapour pressures, specific volumes, enthalpies at saturation and superheat and specific heats. A new form of equation of state is employed which has some validity through the critical region. The results of the investigation indicate a satisfactory state of thermodynamic consistency over the liquid-vapour range with respect to vapour pressures and saturation volumes deduced from the measured vaporization quantities using the Beattie corrections to the international temp. scale. The consistency test includes also verification of the accuracy and usefulness of the new functional relation for the vapour phase, $p = F(v, T)$ whose parameters were determined from the measured superheat p–v–T data. The superheat enthalpy data to 550°C at zero pressure is, however, not consistent with the present theoretical information pertaining to C_p^0. The computed enthalpies of the vapour to 550°C and pressures of 300 kg/cm² are satisfactory provided an empirical correction term is subtracted from the theoretical values of C_p^0. The accuracy of the Keenan–Keyes steam tables values of specific volume, pressure and enthalpy is confirmed. [See Abstr. 3524 (1947)]. A.

536.75

1737. Vapor pressure and other thermodynamic data for *n*-hexadecane and *n*-dodecylcyclohexane near room temperature. G. S. PARKS AND G. E. MOORE. *J. Chem. Phys.*, **17**, 1151–3 (*Nov.*, 1949).

536.75

1738. Thermodynamic functions for tritium deuteride. The dissociation of tritium deuteride. Equilibria among the isotopic hydrogen molecules. W. M. JONES. *J. Chem. Phys.*, **17**, 1062–4 (*Nov.*, 1949).

The heat capacity, entropy, internal energy and free energy are calculated to 2 500°K. Equilibria of the isotopic hydrogens among themselves are calculated. A.

536.75

1739. Thermodynamic properties of oxygen fluoride and chlorine fluoride from spectroscopic data. R. L. POTTER. *J. Chem. Phys.*, **17**, 957–9 (*Oct.*, 1949).

536.75 : 535.375.5

The infra-red and Raman spectra and the thermodynamic properties of diborane. *See Abstr.* 1672

536.753

1740. A thermodynamic study of liquid metallic solutions. I. The system lead–gold. O. J. KLEPPA. *J. Amer. Chem. Soc.*, **71**, 3275–80 (*Oct.*, 1949).

The chemical potentials and partial molar entropies of mixing for Pb in liquid Pb–Au mixtures have been determined by the electromotive force method for

compositions up to 79 atomic % Au. From these data have been calculated for both components activities at 600°, "entropy fractions," and relative partial and integral molar heats of mixing. It was found that the deviation of this mixture from Raoult's law can be largely attributed to a non-ideal entropy of mixing. The heat and free energies of formation for $Au_2Pb(s)$ from liquid Pb and undercooled liquid Au at about 400° were calculated using information from the established equilibrium phase diagram of Au–Pb and from this investigation. A.

536.753

1741. Thermodynamics of ternary liquid mixtures. R. HAASE. *Z. Naturforsch*, **4a**, 342–52 (*Aug.*, 1949) *In German.*

A review of the more important fundamental equations in the thermodynamics of ternary liquid mixtures is given. The geometrical representation of the liquid-vapour equilibrium is considered, and the distillation and vapour curves are discussed. The law for the simple distillation of ternary mixtures is deduced on a modern thermodynamic basis. New laws on the change of b.p. during distillation are given, which are in agreement with the experimental results of Reinders and de Minjer. The laws for the shape of the distillation curves given by van der Waals and others are shown to be dependent on thermodynamic relationships which can be used to indicate the assumptions for which these laws hold good. A. J. MEE

ELECTRICITY 537

537.081.1 : 621.3.081

1742. Introduction of Giorgi system of units. H. KÖNIG, M. KRONDL AND M. LANDOLT. *Bull. Ass. Suisse Elect.*, **40**, 462–74 (*July* 23, 1949) *In French.*

An explanation of the rationalized Giorgi system of units following the recommendation of their general adoption by the Comite Electrotechnique Suisse. Numerical examples of the use of tabulated conversion factors are given. A. J. SMALL (R)

537.081.1 : 621.3.081.3

1743. Proposals and recommendations concerning the definitions and units of electromagnetic quantities. P. CORNELIUS. *Philips Res. Rep.*, **4**, 232–7 (*June*, 1949).

A continuation of an earlier paper [*ibid.*, 123–42 (*April*, 1949); Abstr. 3058 B (1949)]. Recommendations suggested simplify the transition from the c.g.s. to the rationalized Giorgi system. A. J. SMALL (R)

THEORY . ELECTRONS 537.1

537.12 : 530.145

The theory of the Dirac electron in momentum space. *See Abstr.* 1483

537.1

1744. On the classical theory of the electron. R. UTIYAMA. *Progr. Theor. Phys.*, **3**, 219–28 (*Ju*
Sept., 1948).

Previous calculations [Abstr. 4748 (1949)] a repeated using one common time instead of a "man time" construction. When specialized to po electrons the equation of motion of Dirac is obtain G. J. KYN

537.122 : 530.1

On the exchange effects between electron a positron. *See Abstr.* 1504

537.122 : 530.14

The electromagnetic properties of the electr *See Abstr.* 1511

ELECTROSTATICS . DIELECTRICS 537.2

537.2

1745. Potential problems and capacitance for conductor bounded by two intersecting sphere C. SNOW. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 37 407 (*Oct.*, 1949).

Formal expressions, as series and integrals, a derived for the external potential, which takes c assigned values on the two spherical bounda surfaces—either when the body is alone or when is in any given axially symmetric electrostatic fiel This is effected by representing a given functic $f(x)$, for $1<x<\infty$, as a complex integral whos variable is the parameter μ of a Legendre functio $P_{\mu-\frac{1}{2}}(x)$ or $Q_{\mu-\frac{1}{2}}(x)$. The capacitance of the co ductor is found as a series, whose terms involve ps functions and vanish with $1/n$ like n^{-2}. This transformed into a formula depending upon a seri whose n^{th} term vanishes with $1/n$ like n^{-14}. In cas the two spheres intersect at an angle ω, which is rational fraction of 2π, the capacitance is given i finite terms involving complete elliptic integral which is $Q_{-\frac{1}{2}}$. The field, or electrostatic potential i given in finite terms when $\omega = n\pi/m$, where m i any positive integer, and $n = 1, 2, 3$ or 4. Th cases $n = 3$, $n = 4$ involve elliptic functions. Thes would permit the exact computation in finite term of the penetration of an external applied field into cavity with any angular aperture. A

537.222 : 517.94

The application of non-integral Legendre function to potential problems. *See Abstr.* 1380

537.22

1746. Calculation of dipole moments by the theor of Onsager. R. MECKE AND A. REUTER. *Naturwiss enschaften*, **36** (*No.* 8) 251–2 (1949) *In German.*

Onsager's theory is applied to the calculation o dipole moments and the results are compared wit those obtained by the Debye–Clausius–Mosott method. Determinations have been carried out wit strongly associating substances (alcohols and phenols dissolved in solvents of all types. For phenol i indifferent solvents the moment calculated by th Onsager method agrees satisfactorily with the ga value, while the Debye value in the case of pola

olvents is too low. Compounds which form complexes with phenol give moments which are considerably too high. A similar increase in the moment is found for associating substances when the dipole moment of the pure substance is compared with that at extreme dilution. If, however, the association is hindered by inner-molecular bridge formation the dipole moment is practically independent of concentration. The Debye–Clausius–Mosotti relationship gives a completely false picture in this case. The Onsager method makes it possible to determine with accuracy the dipole moments of compounds which, on account of their small solubility in non-polar solvents, cannot be satisfactorily investigated by the Debye method. A. J. MEE

537.226

1747. On permanent charges in solid dielectrics. II. Surface charges and transient currents in Carnauba wax. B. GROSS. *J. Chem. Phys.*, **17**, 866–7 (*Oct.*, 1949).

Permanent surface charges are produced in discs of carnauba wax by exposure to an external electric field. The nature of these charges is studied with a new method of analysis, which is based on the simultaneous measurement of the external current and of the induced charges on the electrodes of the capacitor containing the dielectric. The observed effects are explained by dielectric absorption and by transfer of charge from the electrode to the surface of the dielectric; this latter phenomenon is due to surface breakdown and continuous conduction currents. The results provide an adequate explanation for the electret. A.

537.226.08 : 621.317.77

1748. Variable temperature dielectric cell of wide frequency range for solids and liquids. E. B. BAKER. *Rev. Sci. Instrum.*, **20**, 716–23 (*Oct.*, 1949).

A cell was developed with which power factor and permittivities of solids and liquids can be accurately and conveniently measured from − 25°C to + 150°C and 0 to 200 Mc/s. It uses 7 cm³ of liquid or a solid disc up to 1·5 in. in dia. and up to 150 mil thick. A rapid means of controlling temp. with a circulating oil stream is provided, with a view toward automatic recording *v.* temp. at constant frequency. Thermal expansion of solids may be simultaneously recorded. Fringing errors for solids may be eliminated by using a sample of smaller diameter than the electrodes. A.

537.226.2

1749. Dielectric behavior of solutions of electrolytes in solvents of low dielectric constant. V. The influence of temperature and concentration on dielectric properties. H. A. STROBEL AND R. H. COLE. *J. Chem. Phys.*, **17**, 1141–5 (*Nov.*, 1949).

537.226.2

1750. Dielectric losses in some crystalline substances at high frequencies. K. A. VODOPYANOV. *J. Tech. Phys., USSR*, **19**, 1067–73 (*Sept.*, 1949) *In Russian.*

The two groups investigated were crystalline dielectrics of ionic conductivity and dielectrics with polar molecules. Conclusions drawn: If the structure of the dielectric contains dipoles, an orientating effect may occur at certain frequencies and temps.; and if these frequencies are low, then the temp. maximum of the loss angle coincides with a variation of the dielectric constant; in the range of high frequencies the dielectric constant varies insignificantly. The orientation of dipoles, parts of a whole molecule or molecule groups requires favourable conditions, depending on the bond energy or activation energy. According to the structure of the substance several values of activation energy might exist for the same molecules. B. F. KRAUS

537.226.2 : 621.315.612.011.5

1751. Properties of calcium-barium titanate dielectrics. E. N. BUNTING, G. R. SHELTON and A. S. CREAMER. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 237–46 (*Sept.*, 1949).

Dielectrics having compositions in the system $3CaO : TiO_2$–$BaTiO_3$–TiO_2 were matured at 1 260° to 1 500°C. Data are given for the compositions, heat-treatments, absorption, shrinkage, and for K, the permittivity, and Q, the reciprocal of the power factor, at 25°C for frequencies of 50, 1 000 and 20 000 kc/s and for 3 000 Mc/s when K is not > 50. Values of K were also determined at 1 Mc/s for various temps. from − 60° to + 85°C. Lowest values of Q (and highest of K) were associated with specimens of high baria content. Linear thermal expansion (25° to 700°C) ranged from 0·65 to 0·87%. The specimens of some compositions were unstable and changed in K and Q values with time. A.

537.226.2 : 621.315.612.011.5

1752. The dielectric properties of barium titanate at low temperatures. R. F. BLUNT AND W. F. LOVE. *Phys. Rev.*, **76**, 1202–4 (*Oct.* 15, 1949).

The complex permittivity k of ceramic $BrTiO_3$ has been measured as a function of temp. from 300°K down to 2·8°K. The large value of the slope of the real part of k *v.* temp. in the 4°K region previously reported by Wul [Abstr. 331 (1947)] was observed in the measurements described here, and a large hump in the tan δ *v.* temp. curve was observed at low temps. Measurements were also made on $BaTiO_3$ diluted with 15% and 30% $SrTiO_3$. The dilution in both cases gave large slopes in the k *v.* temp. curve at low temp. The measurements were made largely at 500 kc/s. A.

537.226.2

1753. Domain structures and phase transitions in barium titanate. P. W. FORSBERGH, JR. *Phys. Rev.*, **76**, 1187–201 (*Oct.* 15, 1949).

The arrangements of domains that arise in single crystals of barium titanate in the ferroelectric tetragonal phase have been studied in detail. The domains are the result of tetragonal (101) twinning, and appear by the formation of wedge-shaped laminar domains between two converging (101) twin planes. The distance of penetration of thin wedge-shaped laminae into the crystal follows changes in an applied electric field reversibly. A preliminary investigation of the phase transitions near 5°C and − 70°C has been completed. The crystal is orthorhombic *Cmm* between 5°C and − 70°C, and trigonal *R3m* below − 70°C, with the lattice stretched along the polar axis. The twinning is identified in terms of these lattices. It is maintained that the transitions near 5°C and − 70°C can only be of the first order, in contrast with the λ-transition at 120°C. While a

statistical mechanical treatment of the properties of barium titanate would be exceedingly difficult, a definite qualitative thermodynamic correlation of its properties has been made. Due to the piezoelectric "interaction," the free energy can be visualized in the ferroelectric states in terms of a simultaneous polarization and lattice deformation. A.

537.226.2

1754. Directional effects in dielectric properties of molded rubber. A. H. Scott. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 355–64 (*Oct.*, 1949).

Slabs of rubber-filler mixtures were prepared in such a way that flow in sheeting and moulding was greatly accentuated in one direction. This paper describes the method of moulding and gives values of dielectric constant and dissipation factor for measurements made on a variety of mixtures in which the samples were prepared and arranged for measurements in the direction of flow during moulding and in the 2 mutually perp. directions. For some mixtures the values were $\gg$ in one direction than in the others. A possible explanation for this is given. By using cubes of the material as spacers for an optical interferometer, linear thermal expansivities were measured in 3 mutually perp. directions. Some mixtures had greater expansivities in one direction than in others, but there was no correlation with the dielectric constants and dissipation factors. A.

537.226.2 : 548.0 : 535

1755. The electric and optical behavior of $BaTiO_3$ single-domain crystals. W. J. Merz. *Phys. Rev.*, **76**, 1221–5 (*Oct.* 15, 1949).

The permittivities, the spontaneous polarization, and the optical properties of $BaTiO_3$ single-domain crystals have been measured as a function of temp. It is shown that the deformation of the crystal in the tetragonal state is $\propto$ the square of the spontaneous polarization, in analogy to the behaviour of the other ferroelectrics, and that the temp. dependence of the birefringence is $\propto$ the square of the spontaneous polarization. The change of the polarization at the two lower transition points is consistent with the assumption that the Ti ions in the O octahedra are displaced from the [001] to the [011] and later to the [111] direction. A.

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 621.317.723

1756. The use of multigrid tubes as electrometers. J. R. Prescott. *Rev. Sci. Instrum.*, **20**, 553–7 (*Aug.*, 1949).

Details are given for the 6BE6 and 7A8 tubes. Grid currents of between 10^{-13} and 10^{-14}A are obtainable with mutual conductances of the order of 5 μA/V and an amplification factor of 300. A.

537.3 : 621.385

1757. A note on the identity of thermal noise and shot noise. B. Meltzer. *Phil. Mag.*, **40**, 1224–6 (*Dec.*, 1949).

It is shown that the Nyquist noise in an ohmic conductor can be rigorously treated as pure shot noise. A new expression, kT/Re, gives the averag d.c. in either direction in a circuit of resistance, in temp. equilibrium. L. S. GODDAR

537.311 : 621.317.331.081

1758. An absolute measurement of resistance by th Wenner method. J. L. Thomas, C. Peterson, I. Cooter and F. R. Kotter. *J. Res. Nat. Bur. Stand Wash.*, **43**, 291–353 (*Oct.*, 1949).

Reports the results of a project started in 1929 fo the measurement of resistance in terms of lengt time and the permeability of free space. For th method a mutual inductor was constructed whos value was determined within a few parts in 10^6 i terms of its measured dimensions. Resistance wa then measured in terms of this inductance and fre quency, using Wenner's commutated direct-curren method. The results of the measurements give value of 0·999994 absolute ohm for the unit nov maintained at the N.B.S. The dimensions of th mutual inductor were determined in 1938 and agai in 1948. A comparison of the change in inductance because of drifts in dimensions, with the electrica determinations made on the two dates shows tha there has been no appreciable change during th interval in the value of the unit of resistance a maintained at this Bureau. This is the first metho that has been devised to test the stability of the uni to a few parts in 10^6. A

537.31

1759. Distribution of temperature and current in cylindrical bodies. C. F. Muckenhoupt. *J. Appl Phys.*, **20**, 939–42 (*Oct.*, 1949).

The current and temp. distributions in a conductor are affected not only by the magnetic effect of the current, i.e., skin effect, but also by the variation of resistivity with temp. Consequently the 2 are inter dependent, and since the resistance change amounts to between 3 and 4% for every 10°c rise in temp. in metals, and is still greater in insulators, its effect can be quite appreciable. A complete solution for the steady state is given herewith. A.

537.311

1760. High frequency surface resistivity of tin in the normal and superconducting states. W. M. Fairbank. *Phys. Rev.*, **76**, 1106–10 (*Oct.* 15, 1949).

Measurements have been made at a frequency of 9 400 Mc/s of the unloaded Q of a Sn cavity from 74·9°K down to 1·26°K. From the value of the unloaded Q and a knowledge of the geometry of the cavity, the high frequency surface resistivity of white Sn has been calculated as a function of temp. in both the normal and the superconducting states. In the normal state at low temps., the surface resistivity becomes independent of the d.c. resistivity in agreement with workers at other frequencies. In this region the experimental data are compared with the theoretical curves of Sondheimer and Reuter and a value obtained for the number of conduction electrons per atom. Below the superconducting transition temp. the resistivity drops rapidly with temp., approaching asymptotically a value of 1·9% of the value of the resistance at the transition temp. The results are compared with the data of Pippard and the probable dependence of residual resistance on the method of preparing the Sn samples is discussed. A.

537.311.31

1761. Electrical properties of ruthenium. E. JUSTI. *Z. Naturforsch.*, **4a**, 472–4 (*Sept.*, 1949) *In German.*

Measurements were carried out on pressed specimens of Ru (99·99% pure), sintered in high vacuum at 2 200°C after presintering in H_2 at 1 150°C. The density of the specimens was 11·5 g/cm³ as compared with the "X-ray density" of 12·3 g/cm³. The resistivity of 0°C was $7{\cdot}15\times10^{-6}$ Ω-cm, with a mean temp. coeff. (between 0 and 100°C) of 0·449%/°C. A magnetic field of 4×10^4 Gauss produced a resistance change of 15·1%. Measurements of the Hall emf showed that conduction is due to positive holes, contrary to expectation. H. K. HENISCH

537.311.33

1762. On the spontaneous current fluctuations in semiconductors. J. H. GISOLF. *Physica*, **15**, 825–32 (*Sept.*, 1949).

Formulae are derived for the spontaneous current fluctuations in semi-conductors in an electric field. The main features of these formulae are: proportionality of the effective current strength of the fluctuations to the field strength; independence of the fluctuations of the frequency of observation for low frequencies; decreasing effective current strength with increasing frequency for high frequencies; for alternating fields: dependence of the fluctuations on the difference of the frequency of observation and the frequency of the alternating field; proportionality of the effective current strength to the square root of the mean life-time of the free electrons in the semiconductor. A.

537.311.33 : 621.314.63

1763. On the barrier layer theory of dry rectifiers. E. SPENKE. *Z. Phys.*, **126** (*Nos* 1–2) 67–83 (1949) *In German.*

On the basis of Schottky's simplified theory of barrier layers, the concentration of deficit electrons (positive holes) in a Se rectifier is calculated as a function of the applied voltage for various distances from the counter-electrode. The results show that the pronounced asymmetry of resistance is not so much dependent on the variation of barrier thickness with applied voltage as on the changes of charge distribution within the barrier. As a result of this, diffusion currents predominate in the forward direction, whereas the currents produced by reverse voltages are mostly field currents. The action of these distinct mechanisms of current flow is regarded as the fundamental reason for the appearance of pronounced rectification. H. K. HENISCH

537.311.33 : 621.316.8 : 621.315.59

1764. New applications of semi-conductor resistors. H. STRAUBEL. *Z. angew. Phys.*, **1**, 506–9 (*Oct.*, 1949) *In German.*

Resistance elements of high temp. coeff. can be used to indicate the level of a liquid in a tank. A series of such resistors, carrying a load current, are mounted in a vertical tube and connected to separate indicator lamps which are energized when the resistors are hot. Resistors which are immersed in the liquid remain cool. Thus the number of unenergized lamps is a measure of level height. The system is not disturbed by vibrations. It has a time constant of 10–15 sec and can also be adapted for use with electrically conducting liquids. A second application involves the use of similar resistors for the production of intermittent currents. A load current flows through the resistor and an induction coil which is fitted with an armature. When the resistor is hot the large current through the coil causes the armature to be attracted, thereby increasing the coil impedance. This results in a current decrease and hence in a cooling of the temp.-sensitive element. This operation is cyclic. H. K. HENISCH

537.312.5 : 621.383.4

1765. Transformation of PbTe into a photoelectric conductor. O. KRENZIEN. *Z. Phys.*, **126** (*Nos* 7–9) 666–70 (1949) *In German.*

A PbTe photoelectric conductor is produced by vaporizing PbTe at about 900°C on a glass matrix. On introducing O_2 (50 mm Hg, 400°C) the photoelectric sensitivity rises by a factor of 100 to 1 000. The O_2 turns the grey-green telluride into the bright blue tellurate. The spectral sensitivity has a min. at 3·5 μ, a first max. at 1·5 to 2 μ and a second (minor) max. at 4 to 4·4 μ depending on the method of manufacture. The sensitivity extends close to 6 μ. At temps. >400°C the second max. is reduced considerably. W. SUMMER

537.312.62

1766. The phenomenological theory of superconductors. A. R. MILLER. Letter in *Phys. Rev.*, **76**, 1001–2 (*Oct.* 1, 1949).

The derivation of the equation $\text{Ac curl } \vec{J} + \vec{H} = 0$ from the Lagrangian by Cook [Abstr. 3023 (1940)] and Sorokin [Abstr. 5441 (1949)] seemed to dispense with the postulate that the frozen-in magnetic induction $= 0$ originally made by F. and H. London [Abstr. 1797 (1935)]. It is now pointed out that the use of the Lagrangian implies that for every thermodynamical state there is only *one* possible value of the magnetic induction. As this is the theoretical implication of the above postulate it is hardly surprising that the derivation from the Lagrangian leads to the result without further assumptions. H. LONDON

537.312.62

1767. The transmission of electromagnetic forces in a superconductor. W. HEISENBERG. *Nachr. Wiss. Göttingen* (*No.* 1) 23–6 (1947) *In German.*

The stress tensor in F. and H. London's electrodynamics of superconductors [Abstr. 1797 (1935)] contains an additional term $\sim \vec{T}(\vec{J}) = J_i J_k - \frac{1}{2}\delta_{ik} J_l^2$, where the J are the components of the current density and $\delta_{ik} = 1$ for $i = k$ and 0 for $i \neq K$. These stresses are discussed in the light of the author's theory of superconductivity [Abstr. 3203 (1947)] and their effect on the electron lattice is calculated. At the maximum current density the resulting lattice distortion can be of the order of 25%. It is pointed out that the fact that the tensor is not of the simple form $\delta_{ik}P$ can hardly be interpreted otherwise than that the electrons are held in a rigid state, that is to say, in a lattice. H. LONDON

537.312.62

1768. Superconductivity and the Bohr magneton. E. U. CONDON. *Proc. Nat. Acad. Sci., Wash.*, **35**, 488–90 (*Aug.*, 1949).

It is pointed out that the maximum magnetization

of a superconductor is K times less than a magnetization of one Bohr magneton per atom, where K is a number of order 10 and frequently close to an integral multiple of 5. The dimensional relation implied is the same as one proposed by London [Abstr. 776 (1946)]. D. SHOENBERG

537.312.62

1769. Some properties of superconductors below 1°K. II. Aluminum and zinc. J. G. DAUNT AND C. V. HEER. *Phys. Rev.*, **76**, 1324–8 (*Nov.*, 1949).

Magnetic measurements of the threshold curves of superconducting Al and Zn of very high purity have been carried out down to 0·3°K. Calculations have been made therefrom of the entropy differences between the normal and superconducting states and of the specific heats of the electron assemblies in both the normal and superconducting states. The value of the linear term for the normal electronic specific heat for Al was found to be $2{\cdot}59\times10^{-4}T$ cal./mole/degree and for Zn $1{\cdot}36\times10^{-4}\,T$ cal./mole/degree. A.

537.312.8 : 538.245

Influence of thermomagnetic treatment on electrical resistance of alnico. *See Abstr.* 1875

ELECTRIC DISCHARGES 537.52

537.523.4

1770. On the theory of the spark breakdown. H. G. MÖLLER. *Elektrotechnik, Berlin*, **3**, 291–3 (*Sept.*, 1949) *In German.*

The time which elapses between the application of a voltage to an over-volted spark gap and the development of full breakdown (i.e. short-circuit) current is too short for electrons to cross the gap. A new theory of breakdown is proposed, based on assumptions: (*a*) the gap-voltage collapses when a current ($\simeq$ short-circuit value) appears in the parallel electric circuit, and (*b*) the current in that circuit begins to flow as soon as electrons move away from the cathode, i.e. *before* they reach the anode. To calculate breakdown times it is assumed that the electrons must travel a minimum distance necessary to produce about 10^{13} electrons by ionization. Such distances are much shorter than the full gap width; the resulting times are in good agreement ($\simeq 6\times10^{-9}$ sec) for high overvoltage, but less good for a low overvoltage. F. LLEWELLYN JONES

537.523.5 : 621.315.5.066.6 : 621.3.014.31

1771. Erosion of electrical contacts on make. L. H. GERMER AND F. E. HAWORTH. With Appendix: **Effect of steady value current upon erosion.** D. P. LING. *J. Appl. Phys.*, **20**, 1085–109 (*Nov.*, 1949).

When an electric current is set up by bringing two contacts together, they necessarily discharge a capacitance. If the discharge takes place through an arc before the metallic circuit is established, erosion of the electrodes results. In a l.v. circuit the occurrence of an arc depends upon the condition of the electrode surfaces and upon the circuit inductance. For "inactive" surfaces, and a voltage of the order of 50, an arc does not occur if the inductance is $>3\ \mu$H. Surfaces of various metals can be "activated" by vapours of certain unsaturated organic compounds, and in the active condition they give arcs even when the circuit inductance is $>$ this limiting value by a factor of more than 10^3. When an arc occurs at the make of inactive metal surfaces, its energy, which in l.v. circuits of practical interest is drawn entirely from a charged condenser, is dissipated almost entirely upon the positive electrode, and melts out a crater intermediate in volume between the volume of metal which can be melted by the energy and that which can be vaporized. Some of the melted metal lands on the negative electrode and, with repeated operation, results in a mound of metal transferred from anode to cathode. This transfer is about 4×10^{-14} cm^3 of metal per erg. The arc voltage is of the order of 15 V. If the initial circuit potential is $>$ about 50 V there may be more than one arc discharge, successive discharges being in opposite directions and resulting in the transfer of metal in opposite directions, always to the negative electrode. A.

537.525

1772. On the normal cathode fall in neon. F. M. PENNING AND J. H. A. MOUBIS. *Physica*, **15**, 721–32 (*Sept.*, 1949).

Applying the same method which had furnished reproducible results for Mo [Abstr. 2613 (1946), 2160 (1947)] the normal cathode fall V_n in Ne has been determined for a number of other materials (plate cathode, 40 mm pressure). The values of V_n are compared with those of the work function ϕ and large deviations have been found from the relation $V_n = C\phi$ (C a constant). A.

537.525 : 621.385.1 : 621.385.38

1773. On controlling the low pressure mercury discharge. A. HAUG. *Z. angew. Phys.*, **1**, 323–9 (*March*, 1949) *In German.*

Reports results of an investigation on a tube consisting of oxide cathode and mesh anode in which a discharge is maintained. Beyond the mesh anode is located a triode system of cathode, grid and anode. The characteristics of the triode were measured and the transition from the high-vacuum tube is discussed. A. H. W. BECK

537.525 : 621.385.1 : 621.385.38

1774. Theory of the controlled low pressure mercury discharge. A. HAUG. *Z. angew. Phys.*, **1**, 367–73 (*May*, 1949) *In German.*

The theory of the effects described in the preceding paper is given. The theory is deduced for the model of a bipolar stream taking convection, diffusion and space-charge into account. A. H. W. BECK

537.525.3 : 537.564

1775. Secondary ionization processes in molecular gases. G. MEDICUS. *Z. angew. Phys.*, **1**, 106–36 (*July*, 1948) *In German.*

A comprehensive discussion and analysis of previous experimental data on ionization processes in the Townsend discharge in H_2, both for corona and for parallel plates, leads to the conclusions that secondary electron production is due mainly to the action of positive ions in the gas and to the action of photons on the cathode and on the gas molecules, and not to the direct action of positive ions on the cathode. It is suggested that ionization of gas molecules (probably for all non-noble gases) by positive

ions takes place by a process in which the kinetic energy of the ions is first transferred to neutral atoms which only then are ionized by collision: this modified process can be represented by coeff. β as is the original Townsend process of ionization by collision by positive ions. F. LLEWELLYN JONES

537.525.5

1776. The behaviour of the cathode spot on an undisturbed mercury surface. K. D. FROOME. *Proc. Phys. Soc. B*, **62**, 805–12 (*Dec.*, 1949).

The cathode spot of transient Hg arcs has been studied by means of a Kerr cell apparatus capable of taking many superimposed photographs. Discussion is limited to times when the spot is moving with sufficient velocity not to disturb the Hg surface. It is found that for a given current the "spot" takes the form of a line, or broken line, of total length $\propto$ the current. This is also true for a spot in a magnetic field. If the current rises slowly, the length of the line increases $\propto$ the current; but if the rate of growth of current is $>$ a value lying between $\pi \times 10^7$ and $2\pi \times 10^7$ A/sec, then fresh spots form and spread out radially from the point of formation into lines moving with a max. velocity of about 10^4 cm/s. It is found that this velocity is never greatly exceeded whatever the experimental conditions. The current density is $> 10^6$ A/cm^2. A.

537.527.5

1777. The characteristics of arc discharge in the heavy inert gases under very high pressures. D. A. GOUKHBERG. *Izv. Akad. Nauk, SSSR, Otdel. Tekh. Nauk.* (*No.* 9) 1297–1306 (*Sept.*, 1949) *In Russian.*

D.c. arcs in A, Kr and Xe up to 40 atm. are fully examined and are similar to each other. They are economical, stable, and they reach their final brightness in 3 min. In Kr at 38 atm., current 7·5 A, the anode and cathode potential drops are 12 V together and the field in the gap is 30 V/cm. The arcs show considerable continuous emission in the u.v. (H lamp) and the visible and show strong emission lines from 7 000 to 10 000 Å. The intensity in the u.v. varies as the square of the current. Approx. colour temp. = 5 400°K. D. H. WHIFFEN

537.525.8

1778. Relaxation oscillations in discharge tubes: application to the study of the glow. J. MOUSSIEGT. *Ann. Phys., Paris*, **4**, 593–670 (*Sept.–Oct.*, 1949) *In French.*

A comprehensive study, in three parts, of the intermittent glow discharge obtained in a simple C–R circuit. Part 1 is a detailed experimental study of the static characteristics of a commercial low-pressure Ne tube containing traces of A; extinction voltages, production of relaxation oscillations, cycles of relaxation, and factors influencing the max. discharge current were examined. Part 2, mainly theoretical, revises elementary theory of relaxation oscillations by introducing notion of inaccessibility of certain points on the characteristic curve by taking into account influence of residual space-charge in the gas between times of extinction and re-striking of the glow. Attention is directed to the max. and min. tube voltages, and to the period when the current passes through the max. a short time after re-striking. Part 3 gives calculations of the time-constant ($\simeq 200\ \mu$s), and shows that theory is verified by experimental data obtained with particular discharge tube used. F. LLEWELLYN JONES

537.529 : 548.0

1779. Electric breakdown in ionic crystals. H. B. CALLEN. *Phys. Rev.*, **76**, 1394–1402 (*Nov.*, 1949).

The electric breakdown strength of ionic crystals at low and moderate temps. is calculated on the basis of von Hippel's low energy criterion. Fröhlich's method of calculation, modified to take account of the electronic polarizability of the ions, is employed. The breakdown strength at $T = 0°$ is $F_0(\text{V/cm}) = 134 \times 10^6 (\hbar\omega_t)_{\text{ev}} [(\varepsilon_s - \varepsilon_0)/(\varepsilon_s \varepsilon_0^3)^{\frac{1}{2}}](m^*/m)$ where $(\hbar\omega_t)_{\text{ev}}$ is the reststrahl energy in electron volts, ε_s and ε_0 are the static and optical values of the permittivity, and (m^*/m) is the ratio of the effective mass to the free electron mass. The breakdown strength increases slowly with increasing temp. The lack of dependence of the breakdown strength on crystallographic orientation and the strong directional dependence of the breakdown paths are qualitatively accounted for. A.

X-RAYS 537.531

537.531 : 535.314

1780. X-ray images by refractive focusing. P. KIRKPATRICK. *J. Opt. Soc. Amer.*, **39**, 796 (*Sept.*, 1949).

The approx. conditions are given for refractive focusing of X-rays using a prism having a concave curvature at the face of emergency of the outgoing beam. The *K* line spectra of Mo have been photographed with such converging prisms. The focusing is practically that of a cylindrical lens, even though the actual surface curvature may be spherical. The circular aberration has been found as serious as that of reflection focusing. Since all refracting materials are absorbing in the X-ray region only the portion of the prism within a few μ of the refracting angle will pass appreciable radiation. Hence the prism aperture is so narrow that diffraction plays an appreciable part in determining the width of a slit image. An X-ray lens capable of producing a point image of a point object (using monochromatic radiation) would consist of two focusing prisms mounted close together with their refracting edges normal to each other. The point focusing by two strongly astigmatic optical elements would be in complete analogy with the focusing of X-rays by two mirrors. Such an X-ray lens has, however, the disadvantage of high absorption and strong chromatic aberration and would probably be inferior to mirror systems. R. H. HERZ

537.531 : 537.533.72 : 614.8

1781. Radiation survey of X-ray output of an electron microscope from personal hazard viewpoint. L. B. SILVERMAN, S. B. ELLIOT AND M. A. GREENFIELD. *Science*, **110**, 376–7 (*Oct.* 7, 1949).

Measurements of the intensity of X-rays emitted from an electron microscope operated at 50 kV and 200 μA indicated that at the port of the primary viewing screen it was $\sim$1 500 mr/hr, while the tolerance dose is 50 mr/day. The H.V.L. in Al was

found to be 1–1·7 mm, corresponding to the X-ray spectrum arising from 50 kV electrons. A ¼″ plug of Pb glass placed in each viewing port reduced the dosage rate to < 1 mr/hr. The high dosage rate had been due to the accidental use of ordinary glass instead of Pb glass in the assembly of the instrument. T. A. CHALMERS

537.531 : 621.386.1 : 620.179.15

1782. X-ray flash tubes and their applications. W. SCHAAFFS. *Z. angew. Phys.*, **1**, 462–73 (*Aug.*, 1949) *In German.*

A high vacuum X-ray flash tube for high-speed radiography has been designed as an improved development of similar tubes containing Hg vapour. Constructional details of the new tube are given. This can be operated at 100 kV with flashes down to 3×10^{-8} sec at several kA. Apart from the uses of high-speed radiography in the study of ballistic phenomena and foundry technique, physical applications are described, such as the investigation of spark discharges across insulating liquids, arc discharges between carbon electrodes, the study of the influence of sound waves on the motion of solid bodies embedded in liquids and others. The advantages of using X-ray instead of light flashes in these investigations are emphasized. R. H. HERZ

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 621.384.6

1783. Extraction of the electron beam from an electron accelerator. K. GUND AND H. REICH. *Z. Phys.*, **126** (*No.* 5) 383–98 (1949) *In German.*

A combination of a thin scattering foil and electrostatic deflection as in cyclotron extraction can be used to extract up to 70% of the rotating beam in a beam of narrow solid angle. The scattering foil thickness is so chosen that 95% of the electrons are scattered < 1·15°. For a 4·6 MeV betatron the foil is Al 0·015 mm thick and 0·05 mm wide. 30 kV on the deflector plate gives a field of 150 kV/cm. The beam is brought out into air through a 0·02 mm Cu window. In air the beam was a cone of 11° half-angle. Ionization strength at the window was 3×10^{5}r/min. W. I. B. SMITH

537.533 : 621.384.6 : 621.385.833

1784. Electron-optics of the betatron. E. SCHWARTZ. *Z. Naturforsch.*, **4a**, 198–204 (*June*, 1949) *In German.*

The paths of electrons for the first few revolutions after injection are determined for a divergent electron beam. The acceptance time increases with injection voltage and flatness of the magnetic field. The acceptance angle increases with flatness of magnetic field and is independent of injection voltage, and during the injection interval rises from zero to a maximum and falls back to zero again.

W. I. B. SMITH

537.533 : 621.385.833

1785. Electron flow in curved paths under space-charge conditions. B. MELTZER. *Proc. Phys. Soc. B*, **62**, 813–17 (*Dec.*, 1949).

Further developments in a method of obtaining solutions of space-charge flow, described in a previous paper [Abstr. 4819 (1949)] are presented. A single example of 3-dimensional flow is given, as well as a number of general theorems. A distinction is drawn between "normal" flow, in which all electrons have the same energy (example: a thermionic device with a unipotential cathode) and "abnormal" flow, in which they may have different energies. It is shown that in the case of the former the application of the general method simplifies considerably. A.

537.533.7 : 548.0

1786. The passage of slow electrons through alkali halide crystals. O. KRENZIEN. *Z. Phys.*, **126** (*Nos* 3–4) 365–76 (1949) *In German.*

A thin layer of the halide was evaporated on to a small metal plate, mounted inside a metallized glass sphere, and a parallel beam of electrons directed on to it. The current flowing out through the collecting sphere being called I_A and that flowing through the plate I_P, the "scatter number" Z is defined by $Z = I_A/(I_A + I_P)$. This was plotted against the kinetic energy (0 to 12 eV) of the incident electrons, for various substances and various angles of incidence. The positions of the minima observed in the curves are related to the optical absorption bands of the substance and the crystal structure. M. R. HOPKINS

537.533.72

1787. Erratum: Conditions for optimum luminosity and energy resolution in an axial β-ray spectrometer with homogeneous magnetic field. J. W. M. DUMOND. *Rev. Sci. Instrum.*, **20**, 616 (*Aug.*, 1949).

See Abstr. 3255 (1949).

537.533.72 : 538.122

Electron optical observation of magnetic fields. *See Abstr.* 1860.

537.533.72 : 621.385.833

1788. An improved method of numerical ray tracing through electron lenses. G. LIEBMANN. *Proc. Phys. Soc. B*, **62**, 753–72 (*Dec.*, 1949).

An improved method is described for the tracing of electron trajectories through electron lenses by integrating the general ray equation with the help of Taylor's series, taking the series up to and including fourth-order terms. The paraxial trajectory is obtained by progressing from point P_n on the trajectory to point P_{n+1} with the help of recurrence formulae $r_{n+1} = Q_1 r_n + Q_2 r'_n$ and $r'_{n+1} = Q_3 r'_n + Q_4 r_n$ where the coeffs. $Q_1 \ldots Q_4$ are functions of the electrostatic or magnetic field distribution along the axis. The deviation of the first-order trajectory from the paraxial trajectory is built up with the help of similar recurrence formulae. The method is first developed for combined electrostatic and magnetic lenses, using the "equivalent potential" $U = \Phi - eA^2/2m$, and then specialized for pure magnetic or pure electrostatic lenses. The case of space charge within lenses is also considered. Comparison of the improved method with other methods shows that it is faster and capable of high accuracy. The factors influencing the accuracy are considered in detail and a short-cut method using extrapolation is given. A fully calculated example is appended. A.

537.533.8

1789. Lilienfeld radiation and the possibility of its explanation by electrostatic plasma oscillations on the metal surface. K. SOMMERMEYER. *Z. Naturforsch.*, **4a**, 440–8 (*Sept.*, 1949) *In German.*

The conditions for the appearance of Lilienfeld radiation from the anodes of X-ray tubes are examined afresh; the excitation functions are S-shaped curves, and the light production efficiency amounts to 0·1 light quanta per incident electron. Interpretation of the light as "de-celeration" radiation is unacceptable, and as fluorescence is extremely improbable: the most probable cause is a plasma oscillation at the metal surface.

F. LLEWELLYN JONES

537.534

1790. The effect of space-charge on the focusing properties of a 180° mass spectrometer. C. F. ROBINSON. Letter in *Rev. Sci. Instrum.*, **20**, 745 (*Oct.*, 1949).

An approximate expression is derived for the perturbation by space charge of the radius of curvature of ions moving in a magnetic field, and a graphical construction shows that, where a single beam is formed, the first order effect of space charge is to shift the focus of the beam. Also, on a plausible assumption, the width of this focal spot is unchanged by space charge. This result disagrees with that of Smith *et al.* [Abstr. 704 (1949)], and although the analysis is less valid in the practical case of a heterogeneous beam, allowance for the shift of the focal point should often improve resolution where space charge is high. T. G. PICKAVANCE

537.534

1791. Anomalous negative peaks in mass spectra. A. G. SHARKEY, JR. AND R. A. FRIEDEL. Letter in *J. Chem. Phys.*, **17**, 998 (*Oct.*, 1949).

Negative peaks due to N, O, CO and CO_2 were collected in a normal type of mass spectrometer, with abundances relative to the positive peaks $2{\cdot}9–5{\cdot}9\times10^{-4}$ and with heights roughly $\propto$ the pressure. They appeared with various ion sources, and are assumed to be produced with low velocity near the exit slit of the analyser, probably in a non-conducting layer on the slit plate. T. G. PICKAVANCE

537.534

1792. Construction and calibration of a cylindrical electrostatic analyzer. S. K. ALLISON, S. P. FRANKEL, T. A. HALL, J. H. MONTAGUE, A. H. MORRISH AND S. D. WARSHAW. *Rev. Sci. Instrum.*, **20**, 735–44 (*Oct.*, 1949).

A cylindrical electrostatic deflector has been constructed with average radius 15 cm, spacing 0·5 cm and deflection 90°, in which the deflecting potential can be in the neighbourhood of 50 kV. Thus protons up to 0·75 MeV can be focused. Movable slits have been incorporated in the design, and the geometry of the entrance and exit apertures of the deflecting channel is such that the stray field may be calculated analytically. This has been done for the case in which the deflecting plates are symmetrically charged above and below zero potential. The predictions have been compared with experiments on the focusing of electron beams by the instrument under controlled conditions. Agreement with the calculations is demonstrated within the accuracy of the experiments, which is about 0·3%. Experiments with asymmetric charging of the electrodes are reported and shown to agree with a plausible extension of the theory. Further experiments investigated the effect of small displacements of the slits from the computed focal positions. A set of factors, or calibration constants, has been measured so that, given the co-ordinates of the centres of the entrance and exit slits, and the potentials applied to the deflecting plates, the kinetic energy of the focused ion beam, as it left its source at zero potential, can be calculated to within 0·3%. A.

537.534 : 621.384.6

1793. The electron cyclotron. W. J. HENDERSON AND P. A. REDHEAD. *Nucleonics*, **5**, 60–7 (*Oct.*, 1949).

This accelerator utilizes constant magnetic and r.f. fields, provision being made for the relativistic increase in the orbital periods of the electrons by making the time lag per revolution equal to an integral number of periods of the accelerating field. A 5 MeV electron-cyclotron is described, employing a 995 gauss magnetic field and an r.f. field of 2 800 Mc/s, which accelerates the electrons by 511 keV per revolution, giving them mass increments equal to the rest mass m_0. The r.f. from a magnetron is supplied (in 2 μsec pulses with repetition frequency 435/sec) to an ellipsoid-hyperboloid cavity. Electrons are produced by field emission inside the cavity and emerge from a hole in the pole, with k.e. of 511 keV and mass $2\,m_0$. The period of the first orbit is exactly double the period of the r.f. After a second transit of the accelerating cavity the electrons have masses $3\,m_0$ and the orbital period is increased to 3 r.f. periods and so on. The current in the first orbit is of the order 100 μA, but only 1% of this is trapped in the second and subsequent orbits. A brief outline of the theory of the electron cyclotron is given. The phase-focusing process is similar to that of the synchrotron and analysis shows that the phase-stable region is $> 20°$. The electron-cyclotron is thought to have many advantages over other accelerators in the region above 10 MeV. L. R. SHEPHERD

537.534.72

1794. Improved magnetic focusing of charged particles. H. HINTENBERGER. Letter in *Rev. Sci. Instrum.*, **20**, 748–50 (*Oct.*, 1949).

A general second-order focusing condition is given, for particles passing through a region of uniform magnetic field with foci outside the field. Previously published cases [e.g. Abstr. 6260 (1949)] are special cases of this condition. Diagrams show some possible field shapes for deflection angles of 90° and 60°.

T. G. PICKAVANCE

537.534.72

1795. The determination of mass spectra by the measurement of times of flight. R. KELLER. *Helv. Phys. Acta*, **22** (*No.* 4) 386–8 (1949) *In French.*

Describes, with references and diagrams, a method for displaying mass spectra on a c.r.o. A Penning ion source is used, since this may conveniently be modulated in order to produce the burst of ions necessary for the observation of varying times of flight. A sample mass spectrum, taken with a D_2/O_2 mixture, is shown. J. D. CRAGGS

537.534.72 : 621.319.5 : 621.316.722

1796. Stabilized high voltage power supply for electrostatic analyzer. R. L. Henkel and B. Petree. *Rev. Sci. Instrum.*, **20**, 727–32 (*Oct.*, 1949).

An a.c. operated power supply has been developed which furnishes voltage for the electrostatic analysers for the University of Wisconsin electrostatic generator. Voltage is continuously variable from about 5 000 to 50 000 with stability and accuracy of measurement within $\pm 0{\cdot}01\%$. The stabilizer is of the usual degenerative type, but the error signal is amplified by a phototube galvanometer d.c. amplifier and applied to a series impedance in the h.v. transformer primary circuit. The generator beam energy automatically follows adjustments of a l.v. potentiometer used for voltage measurements in this supply. A.

537.534.74

1797. Phase shifts in proton-alpha-scattering. C. L. Critchfield and D. C. Dodder. *Phys. Rev.*, **76**, 602–5 (*Sept.* 1, 1949).

Phase-shifts in S and P waves are found that fit the observed scattering of protons by He^4 within the experimental accuracy of the recent Minnesota results [Abstr. 4828 (1949)]. The S wave phase is negative and rather small. The $P_{\frac{1}{2}}$ and $P_{3/2}$ waves have different phase-shifts, both positive, but there are two sets of possible values, one corresponding to a normal doublet in Li^5, the other to an inverted doublet. In both cases there is resonant scattering and strong polarization of the proton beam. Measurement of the polarization would decide between the doublets. The values of the phase-shifts presented are those that minimize the sum of squares of % differences between observed and calculated differential cross-sections. A.

537.534.74

1798. Angular distribution of 10·8 Mev deuterons scattered by deuterons. J. C. Allred, K. W. Erickson, J. L. Fowler and E. J. Stovall, Jr. *Phys. Rev.*, **76**, 1430–2 (*Nov.* 15, 1949).

Cross-sections have been measured for 10·8 MeV at laboratory angles from 17·5 degrees to 57 degrees at 2·5 degree intervals. The d beam from the Los Alamos cyclotron was focused on a thin gas target containing D, and the scattered deuterons were detected in a proportional counter. A selsyn-controlled foil shutter mounted in front of the counter prevented He^3, and H^3 at angles > 40 degrees, from entering the counter. H^1, and H^3 at the smaller angles, were discriminated against by using a 10-channel pulse amplitude analyser. The experimental curve is symmetrical about 90 degrees in the centre of mass system. A.

537.534.74

1799. Scattering of protons by tritons. A. Hemmendinger, G. A. Jarvis and R. F. Taschek. *Phys. Rev.*, **76**, 1137–41 (*Oct.* 15, 1949).

The proton-triton differential scattering cross-section has been measured for laboratory angles between 45° and 135° and proton energies between 0·7 and 2·5 MeV. In this angular range the scattering is predominantly nuclear and shows a rapid increase in intensity for angles $> 90°$ in the centre of mass system. Some indications of anomalous behaviour near the threshold for $T^3(p, n)He^3$ are reported. A.

537.539 : 539.1

On the relations between the cosmic-ray mesons and nuclear mesons. *See Abstr.* 2015

DISCHARGE TUBES . COUNTERS 537.54

537.542

1800. On increased yields with canal ray ion sources. D. Kamke. *Z. Naturforsch.*, **4a**, 391–3 (*Aug.*, 1949) *In German.*

Describes experiments on canal-ray ion sources, using H diffused through Pd. The discharge tube is modified by the use of a projection at the centre of the cathode surface, facing the anode cylinder, in which the canal is bored. Curves for ion beam currents (unresolved)/discharge tube currents at 20 and 30 kV are given for various values of canal "height," and in the best conditions (30 kV, 8 mA discharge) about 100 μA beam current was obtained. J. D. CRAGGS

537.542 : 537.34

1801. High frequency discharge ion source. H. Neuert. *Z. Naturforsch.*, **4a**, 449–55 (*Sept.*, 1949) *In German.*

A discharge ion source is discussed, and requirements of efficient sources stated. Using a 150 W generator at 2×10^7 c/s, and drawing ions from the glow by means of an electrode at 10 kV and using further acceleration in an additional chamber, ion currents of 1·5 mA can be obtained from H at 10^{-4} mm to 10^{-3} mm pressure. The increase of ion current due to application of a weak magnetic field over tube and chamber is discussed. Examination of energy distribution of ions by electrical deflection was made; magnetic deflection showed that the proportion of atomic ions in the beam was 20%. F. LLEWELLYN JONES

537.542

1802. Ion mobilities in Geiger–Müller counters. H. den Hartog and F. A. Muller. *Physica*, **15**, 789–900 (*Sept.*, 1949).

Formulae and measuring instruments are described for a detailed study of the deionization current in a self-quenching Geiger–Müller counter. More specifically, the recovery characteristic, the dead time, and the break in the current caused by the interception of the ions are analysed. It is shown that all phenomena concerned can be accurately accounted for on the basis of a uniform ion mobility. Ion mobility in alcohol is found to be 2·6 cm/sec per V/cm, in A, 7·1 cm/sec per V/cm, both at 100 mm Hg pressure. Earlier quantitative data given by Van Gemert and the authors [Abstr. 3227 (1947)] are superseded by the present more accurate ones. A.

537.542

1803. Secondary discharges in Geiger–Müller counters and coefficient of liberation of electrons. E. Beretta and A. Rostagni. *Nuovo Cim.*, **6**, 391–6 (*Sept.*, 1949) *In Italian.*

Putman's method [Abstr. 3874 (1948)] was used to determine, from a study of the distribution in time of

the intervals between discharges, the fraction of spurious discharges due to secondary emission from the cathode. In this way it is possible to determine—at least for the case of fast counters—the coeff. k of liberation of electrons. For ethyl alcohol ions striking a metal surface, $k = 0{\cdot}33 \pm 0{\cdot}05 \,.\, 10^{-10}$; for the same ions striking a glass surface, $k = 0{\cdot}05 \pm 0{\cdot}03 \,.\, 10^{-10}$. L. PINCHERLE

537.542

1804. Tests of self-regenerating fillings for Geiger counters. S. A. KORFF AND A. D. KRUMBEIN. Letter in *Phys. Rev.*, **76**, 1412 (*Nov.* 1, 1949).

The behaviour of self-quenching Geiger counters containing NH_3 and NH_3/A mixtures is described. Tubes of a normal size have recorded 3×10^{10} counts; starting potentials (10 cm Hg of NH_3) were $\sim 1\,200$ V with 100–125 V plateaus. The spurious counting rate increased during operation, but returned to normal on resting, and the tubes tended to become photo-sensitive, sometimes even to red light. It is suggested that the NH_3, decomposed in the discharges, is also re-synthesized there. J. D. CRAGGS

537.542

1805. A note on perforated cathode self-quenching G–M counters. O. PRAKASH. *Curr. Sci.*, **18**, 337–8 (*Sept.*, 1949).

A brief discussion of mechanisms of formation of spurious counts is given and it is pointed out that the use of gauze, rather than plane, cathodes should lead to the reduction of spurious counts in many cases. Experiments are described with A/alcohol-filled counters of normal size in support of the new suggestion. With a plane Cu cathode the plateau slope (over about 210 V) was 0·06%/V and with a gauze (Cu) cathode the plateau slope was practically zero. J. D. CRAGGS

537.542

1806. Production of end window Geiger–Mueller beta-counters. R. C. HAWKINS, F. N. MACGILLIVRAY AND W. B. MANN. *Nat. Res. Coun. Can. Publ.* (*No.* 1906) 3 *pp.* (1949).

Gives full practical details of the production of counters, on a laboratory scale, with mica windows of 1 mg/cm². L. E. MUSSELL

537.542

1807. Measurement of the efficiency of a Geiger–Müller counter by means of cosmic radiation. M. GUIMARÃES AND P. A. SAMPAIO. *An. Acad. Brasil. Ciênc.*, **21** (*No.* 3) 229–37 (1949) *In Portuguese.*

The resolution time σ of the counter is determined by observations with a c.r.o. Coincidence experiments provide then a relation whereby only a narrow range of values of the efficiency η is compatible with the value found for σ. In the case of a standard counter it was found $\eta = 0{\cdot}977 \pm 0{\cdot}007$. L. PINCHERLE

537.542

1808. Low-rate alpha scintillation counter. B. CASSEN, C. W. REED, L. CURTIS AND L. BAURMASH. *Nucleonics*, **5**, 55–9 (*Oct.*, 1949).

Describes equipment utilizing screens of Zn–CdS phosphor powder in conjunction with a photomultiplier for measuring the α-particle activity of low activity dust samples. L. R. SHEPHERD

537.542

1809. Scintillation counters. W. H. JORDAN AND P. R. BELL. *Nucleonics*, **5**, 30–41 (*Oct.*, 1949).

Luminescent properties, including emission spectrum, emission time, conversion efficiencies for α-particles and γ- and X-rays are reviewed and tabulated for some of the most common phosphors. Relative merits of these phosphors are compared in the light of requirements for efficient α-particle and β- and γ-ray detection and shortness of emission time. Fast neutron detection by organic phosphors and slow neutron detection with phosphors containing B^{10} and Li^6 are discussed briefly. The problem of efficiently collecting on the photomultiplier cathode, the light emitted from a phosphor, is described and examples are given of methods of "piping" light when photomultiplier and phosphor are some distance apart. The causes of fluctuation in the size of pulses from a photomultiplier when monokinetic particles are incident on a phosphor are summarized and a short account of the problem of multiplier noise is given. A scintillation spectrometer developed by the authors for β- and γ-ray energy measurements is described. This employs an anthracene phosphor and a pulse analyser for sorting the pulses from the photomultiplier. The resolution obtained is lower than that obtainable with a magnetic lens spectrometer but the sensitivity is 1 000 times greater. Specimen results are given for β- and γ-spectra of a number of radioisotopes. L. R. SHEPHERD

537.542 : 621.383.4

1810. The characteristics of electron multipliers used as scintillation counters. I. M. AGENO, M. CHIOZZOTTO AND R. QUERZOLI. *R.C. Ist. Super. Sanità*, **12** (*Nos* 4–6) 265–78 (1949) *In Italian.*

A study of the RCA 931 A tube under very low light intensities.

537.542

1811. Analysis of delayed coincidence counting experiments. D. BINDER. Letter in *Phys. Rev.*, **76**, 856–8 (*Sept.* 15, 1949).

A curve is calculated showing the variation of coincidence rate with channel delay, assuming a Gaussian distribution of delays in the counter. The curve shows two regions, one affected by the counter delays, the other only by the source decay. Data recently reported on Hg^{198} [Abstr. 7223 (1949)] are analysed. B. ROSE

537.542

1812. Theoretical study of ionization chamber pulses. P. BILLAUD. *J. Phys. Radium*, **10**, 277–85 (*Oct.*, 1949) *In French.*

A detailed study of the formation and shape of the voltage pulses obtained in an idealized arrangement of ionization chamber and electrometer valve. The various stray capacitances are introduced and the effect of time constants is also studied, for cases where the latter is $\ll$ or $\sim$ electron collection time. The effect of amplifier time constants is briefly discussed, and finally a study of the influence of the direction of the ionizing particles with respect to the inter-electrode e.s. field is given. J. D. CRAGGS

537.542 : 539.16.08

A wide range radiation instrument. *See Abstr.* 1945

537.542 : 615.849 : 621.317.723

1813. A dynamic electrometer for small condenser chambers. W. H. SUTHERLAND. *Brit. J. Radiol.*, **22**, 255–60 (*May*, 1949).

Constructional details are given for a vibrating condenser type dynamic electrometer [*Rev. Sci. Instrum.*, **18**, 298–314 (*May*, 1947)] designed for use with condenser chambers. Calibration shows a linear relation between dose in roentgens and scale reading. Advantages claimed are that the calibration is independent of valve characteristics and of the accuracy of high-value resistors, and that the instrument is robust and portable. T. A. CHALMERS

IONIZATION . THERMIONICS 537.56/.58

537.562

1814. Metastable transitions in mass spectra of hydrocarbons. E. G. BLOOM, F. L. MOHLER, C. E. WISE AND E. J. WELLS. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 65–70 (*July*, 1949).

A compilation of metastable transition peaks in mass spectra of about 170 hydrocarbons. 100 different transitions have been found and identified. These are tabulated according to the mass lost in the transition. Masses lost are 1, 2, 15, 16, 26, 27, 28, 29, 30, 40, 42, 43, 44, 56, 57 and 58. Nearly all transitions can be ascribed to breaking of one bond with or without the transfer of one H atom to the charged or to the neutral fragment. The data include those previously reported in Abstr. 3805 (1948). A.

537.563

1815. Mass spectrum of pentaborane (B^5H_9). V. H. DIBELER, F. L. MOHLER, L. WILLIAMSON AND R. M. REESE. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 97–100 (*Aug.*, 1949).

The mass spectrum has been measured, and the monoisotopic spectrum has been computed using the isotope abundance $B^{10} = 0{\cdot}200$ and $B^{11} = 0{\cdot}800$. The mass spectrum shows that the molecule has a marked tendency for ionization with loss of either 2 or 4 H atoms, but little tendency to lose 1 or 3. The high yield of ions containing 5 B atoms and the tendency to give up either 2 or 4 H atoms suggests a 5-membered ring structure with 2 pairs of loosely bound H atoms. Since the spectrum is quite different from that of C_5 ring compounds, however, no definite conclusion concerning the structure is drawn at present. A.

537.565

1816. On a mobility analyser for gaseous ions. III. Applications of the solutions of the problems dealt with in the study of the electrostatic field between the grid and the plates. P. LANGEVIN. *J. Phys. Radium* (*Sér.* 8) **10**, 257–63 (*Oct.*, 1949) *In French.*

A continuation of two earlier papers [Abstr. 6289 (1949)] dealing with a theoretical study of an apparatus suitable for the measurement of ionic mobilities, and it discusses in detail the electrostatic field in the electrode system of the analyser. The previous studies dealt with arbitrary (simple) potential distributions but the present paper is applicable to the general case, when the electrode potentials may have any value. J. D. CRAGG

537.5

1817. Ionization of paraffin wax by beta-radiation. A. GEMANT. *J. Appl. Phys.*, **20**, 887–91 (*Oct.*, 1949)

A quantitative experimental study of the primary ionization of paraffin wax by β-radiation. Electrons emitted by U and C 14 were used. Interpretation, by means of a simple theory, of experimental data on the electrical conductivity permits evaluation of the ionic mobility in paraffin and the efficiency of ion-pair production. Only small primary ions of relatively long mean life are detected by the conductivity method. Dipolar admixtures promote secondary reactions and lower the level of conductivities attained. No ionization was detected in two hydrocarbon polymers. A.

537.5

1818. Zirconium carbide as a thermionic emitter. R. E. HADDAD, D. L. GOLDWATER AND F. H. MORGAN. Letter in *J. Appl. Phys.*, **20**, 886 (*Sept.*, 1949).

The thermionic constants of Zr carbide cataphoretically coated on W are reported as $\phi = 2{\cdot}1(6)$ eV. $A = 0{\cdot}2 - 0{\cdot}5$ A/deg^2/cm^2. A. H. W. BECK

537.58

1819. The application of Carnot's principle to thermionic phenomena. R. CHAMPEIX. *C.R. Acad. Sci., Paris*, **228**, 1405–6 (*May* 2, 1949) *In French.*

Carnot's principle is used to show that the c.p.d. is correctly given by $\phi_a - \phi_c + kT/e \ln A_c/A_a$ instead of the approximate formula $\phi_a - \phi_c$. A. H. W. BECK

537.581

1820. Thermionic emitting properties of two refractories. R. E. HADDAD, D. L. GOLDWATER AND F. H. MORGAN. Letter in *J. Appl. Phys.*, **20**, 1130 (*Nov.*, 1949).

Thermionic constants are given for Ta carbide and Ti carbide. Ta carbide $A = 2(1)$ A/cm^2 deg K^2, $\phi \approx 3{\cdot}0(5)$ eV. Ti carbide $A = 2(5)$ A/cm^2 deg K^2, $\phi = 3{\cdot}3(5)$ eV. For Ta carbide the spectral emissivity was $0{\cdot}75 \pm 0{\cdot}03$ and for Ti carbide $0{\cdot}96 \pm 0{\cdot}04$. A. H. W. BECK

537.583

1821. A suggestion regarding emission phenomena in (Ba–Sr)O cathodes. E. S. RITTNER, F. K. DU PRÉ AND R. A. HUTNER. Letter in *Phys. Rev.*, **76**, 996–7 (*Oct.* 1, 1949).

Following the conductivity theory of Vink [Thesis, Leiden (1948)] it is suggested that all the donor centres are ionized at temps. above 800°K and that therefore the emission equation should be

$$i = n_b \,.\, e \,.\, (2\pi m)^{-\frac{1}{2}}(kT)^{\frac{1}{2}}(l - r) \exp(-\chi/kT)$$

where n_b = density of donors and χ = work function. Taking $\chi \doteq 1{\cdot}1$ eV, $n_b = 3 \times 10^{17}$/cm^3 and $r = 0$ this gives $\doteq 1$ A/cm^2 at 740°c whereas the usual semi-conductor emission formula predicts $i \doteq 50$ A/cm^2. Thus the agreement with d.c. experiments is much improved. A. H. W. BECK

537.583

1822. Electron emission and conduction mechanism in oxide-coated cathodes. R. Loosjes and H. J. Vink. Letter in *J. Appl. Phys.*, **20**, 884 (*Sept.*, 1949).

Mahlman's [Abstr. 1963 (1949)] measurements of the p.e. effect in which he found $\phi th + E/2 > \phi$ p.e. are explained by Vink's conductivity theory (see preceding Abstr.). Mahlman's E of 1·2 should in this theory be 0·2 − 0·4 eV in which case $\phi th + E/2 = 1{\cdot}7 - 1{\cdot}9$ eV which agrees well with the experimental value of ϕ p.e. = 1·8 eV.

A. H. W. BECK

537.583 : 621.385.032.216

1823. Reversibility of oxygen poisoning in oxide-cathode valves. G. H. Metson. Letter in *Nature, Lond.*, **164**, 540–1 (*Sept.* 24, 1949).

Experimental tests were made on special diodes having normal cathodes and including an O generator comprising a heating element covered with BaO_2 arranged for bombardment with 8 V electrons, giving close control of O emission. When the cathode had stabilized at 1 000°K it was subjected to a stream of O sufficient to reduce its space-charge by 90%. After recovery, further tests were made which confirmed initial measurements. It is stated that after the O atoms or molecules have entered the cathode they become negatively ionized and tend to emerge as negative ions. Alternative theories are discussed. Other experiments suggest that the passage of current through a cathode tends to accelerate the rate of ejection of the gas atoms which lead to reversible poisoning. E. H. W. BANNER (R)

COSMIC RAYS 537.591

537.591

1824. New methods of determining the absolute intensity of cosmic rays in the atmosphere and the residual ionization in ionization chambers. V. F. Hess and R. P. Vancour. *Phys. Rev.*, **76**, 1205–8 (*Oct.* 15, 1949).

The portable Gish–Sherman ionization meter in connection with 4 geometrically similar cylindrical ionization chambers of different size was used for determining (1) the cosmic-ray intensity at sea level when the apparatus is completely shielded from local radiations by 10 cm of Fe, and (2) at the same time a value for the residual ionization produced by spurious α-particles from the walls of the chambers. 2 methods to obtain this end are described: one using all 4 chambers, and the other using the largest chamber and varying the pressure of the filling gas. Plotting the observed ionization v. the ratio of surface: volume gives a straight line which, when extrapolated for infinite volume leads to the value representing the ionization produced by cosmic rays without the secondaries from the wall. A.

537.591

1825. Impulses in ion-chambers caused by cosmic rays. G. M. Avakyants. *J. Tech. Phys., USSR*, **19**, 596–605 (*May*, 1949) *In Russian.*

Theoretical. An expression is derived for the pulse-shape resulting from a given initial distribution of ions. Curves are given for the limiting cases of initially uniform distribution, and columnar. The application to cosmic-ray measurements is discussed.

E. P. GEORGE

537.591 : 523.74

1826. On the origin of the solar component of the cosmic radiation. L. Biermann and E. Bagge. *Z. Naturforsch.*, **4a**, 303–15 (*July*, 1949) *In German.*

Starting from a special model mechanism it is mathematically demonstrated how complex active groups of sunspots can easily produce enormous accelerations of particles, which, along the magnetic lines of force and at large distances from the spot, can lead to their ejection from the sun. Explanations of the corresponding observations by Forbush [Abstr. 915 (1947)], Ehmert [Abstr. 419 (1949)] and others on the correlation of solar events with the intensity of the cosmic radiation are suggested.

A. BEER

537.591.1

1827. Cosmic-ray mesons near sea level. W. L. Kraushaar. *Phys. Rev.*, **76**, 1045–58 (*Oct.* 15, 1949).

The differential and integral intensities of mesons have been studied using delayed coincidence, anti-coincidence and coincidence methods. It is shown that the differential range spectrum of slow mesons is nearly flat out to 100 g cm^{-2} of air-equivalent at sea level and at Echo Lake (3 240 m). The zenith angle distribution of slow mesons has been measured, and can be expressed by $\cos^{3\cdot3}\theta$ at Ithaca [N.Y.] and $\cos^{3\cdot1}\theta$ at Echo Lake. Three independent measurements of the differential intensity of mesons lead to a value of $(6{\cdot}0 \pm 0{\cdot}15) \times 10^{-6}$ sterad^{-1} g^{-1} sec^{-1} at a range of 105 g cm^{-2} of air-equivalent at Ithaca (260 m). The sea level electron intensity is considered, and it is concluded that this intensity is consistent with the electron-2 neutrino decay scheme for the μ-meson provided there is a source in addition to mesons contributing electrons with a very steep zenith angle distribution. A.

537.591.1

1828. The spectrum of mesons as a function of atmospheric depth. C. M. Garelli. *Nuovo Cim.*, **6**, 337–43 (*Sept.*, 1949) *In Italian.*

Starting from some experimental and theoretical data and introducing assumptions valid at high energies, the differential spectrum $g(W)dW$ of mesons is deduced in terms of the atmospheric depth x and of the energy W of mesons. A.

537.591.1

1829. On the angular distribution of mesons produced in photographic emulsions. A. Gamba and L. A. Radicati. *Nuovo Cim.*, **6**, 374–8 (*Sept.*, 1949) *In Italian.*

The angular distribution of the mesons produced in the fast collisions of two nucleons is studied. A formula for the transformation of a probability function from a Lorentz system to another is obtained. The discussion of some photographs obtained by the Powell and Occhialini school permits one to evaluate the order of magnitude for the energy, and for the momentum of the mesons in the centre of mass system of the two colliding particles. For the momentum a value $\simeq mc$ is obtained. A.

537.591.15

1830. Penetrating showers arising in lead. N. SHOSTAKOVICH AND T. ASATIANI. *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 4) 511–12 (1949) *In Russian.*

Observations were carried out at 3 250 m altitude. Transition curves are given of the frequency of showers recorded with 3 banks of counters arranged vertically, separated by Pb screens. The lower 2 banks were divided into 2 separate groups each, making 5-fold coincidences necessary. A correction was applied for extensive showers. The corrected transition curve appears to saturate at ~ 10 cm Pb.

E. P. GEORGE

537.591.15

1831. The distribution of nuclear disintegrations in the vicinity of large showers of heavy particles. A. P. ZHDANOV. *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 5) 657–9 (1949) *In Russian.*

In 1939 a large shower of 100 heavy particles was reported [*Nature, Lond.*, **143**, 3625 (1939)]. Further similar events in a photographic plate have since been recorded. In the vicinity of these "showers" an anomalously high density of smaller stars is observed. These are ascribed to particles, not seen in the emulsion, emanating from the primary shower. Their cross-section for star production must be $\sim 10^{-21}$ cm^2, and it is thought they may be mesons or varitrons. An example is shown. E. P. GEORGE

537.591.15

1832. Auger showers and electronic component of cosmic rays. P. BUDINI. *Nuovo Cim.*, **6**, 402–4 (*Sept.*, 1949) *In Italian.*

The vertical intensity of the electronic component of extensive air showers at high altitudes is calculated under the assumptions that the shower originates from a single heavy particle of high energy and that, for high energies, the primary particle transmits in every collision a constant fraction of its energy to the component which does not produce nuclear explosions. Agreement with experiment is good, though uncertainties both in the theory and in the experimental results do not yet allow of definite conclusions.

L. PINCHERLE

537.591.15

1833. The ratio between the electronic and photonic components [in cosmic ray showers]. E. CLEMENTEL AND L. FABBRICHESI. *Nuovo Cim.*, **6**, 399–402 (*Sept.*, 1949) *In Italian.*

The calculation carried out in previous papers [Abstr. 1966, 1978 (1949)] of the integral spectrum of the electronic component of cosmic-ray showers is extended to the photonic component. The method used is based on a Laplace transformation and is more accurate at low energies than approximations based on solutions of the diffusion equations. Numerical results are given for air and Pb.

L. PINCHERLE

537.591.15

1834. Extensive air showers at high altitudes. H. L. KRAYBILL. *Phys. Rev.*, **76**, 1092–9 (*Oct.* 15, 1949).

The latitude dependence, density properties and lateral extension of extensive cosmic-ray air showers have been studied at 9 200 m elevation, with coincidence counters in a B-29 aeroplane. On a flig between 0° and 63°*N* geomagnetic latitude, r significant variation of shower frequency wi latitude has been detected. Relations between t counting rates of coincidence counter sets of differe orders from threefold to ninefold are in agreeme with a power law density spectrum for the showe with constant negative exponent. The measure value of this exponent is $1{\cdot}73 \pm 0{\cdot}04$ at 9 200 r $1{\cdot}82 \pm 0{\cdot}07$ at 11 000–12 000 m and $1{\cdot}53 \pm 0{\cdot}07$ 720 m. The counting rate of a threefold coincidenc counter set was found to decrease 33% as the tot spread of the counters was increased from 2·8 m t 13 m at 9 200 m altitude. The corresponding decreas at 720 m is 21%. The altitude dependence of th extensive showers was measured up to 12 300 m an a definite max. shower rate has been found near a altitude of 8 000 m.

537.591.1

1835. A cloud-chamber study of extensive ai showers at 3 260 meters elevation. W. W. BROWN AN A. S. MCKAY. *Phys. Rev.*, **76**, 1034–45 (*Oct.* 1 1949).

The penetrating particles in extensive air shower have been observed in a cloud chamber under 6 in o Pb at an elevation of 3 260 m. If a group of ai showers is selected in such a way that their core mostly land between 4 and 24 m from the chamber the penetrating particles are seen to consist mainly of μ-mesons which have been produced in the ai above the apparatus. If a group of air showers is selected so that their cores are mostly < 6 m from the chamber there are again many μ-mesons and in addition there is evidence for local production of penetrating particles in mixed showers and high energy nuclear disintegrations produced by both neutral and ionizing penetrating particles. Thus there is evidence that high energy neutral particles and highly interacting ionizing particles make up an appreciable portion of the penetrating particles in the cores of air showers. There are more cascades of energy $> 10^8$ eV under the Pb shield than can be accounted for by the radiation and knock-on processes of the observed number of mesons. A.

537.591.15

1836. The lateral structure of cosmic-ray air showers. G. COCCONI, V. COCCONI TONGIORGI AND K. GREISEN. *Phys. Rev.*, **76**, 1020–33 (*Oct.* 15, 1949).

The lateral distributions of the electrons and penetrating particles in extensive cosmic-ray air showers have been measured directly, and as a function of the size of the showers. No evidence was found for multiple cores in the showers. The lateral distribution of the electrons was found to agree well with that calculated by Molière, taking into account only Coulomb scattering of the electrons. The density of penetrating particles at a given distance from the core was found to be proportional to that of the electrons. The ratio of p.p. to electrons seems to increase slowly with distance from the core, but changes only by a factor of about 2 between 5 and 100 m from the core, while the electron density decreases by a factor of about 100. Evidence was obtained that most of the penetrating particles reached the apparatus as single, independent particles

rom the air, but that about ¼ of the events in which ›.p. were detected involved groups of particles that vere probably locally produced in the Pb. A.

537.591.15

1837. Specific ionization of extensive shower particles. J. R. PRESCOTT. Letter in *Nature, Lond.*, **164**, 756 (*Oct.* 29, 1949).

In order to correlate measurements on air showers using counters and ion chambers, it is proposed that the total ionization of 100 MeV electrons in A be taken as 107 ion pairs per cm. The correction to be applied to this figure, due to energetic secondaries not completing their paths inside the ion chamber, is evaluated. E. P. GEORGE

537.591.15

1838. Exchange phenomena of the nucleons that generate penetrating showers. H. A. MEYER AND G. SCHWACHHEIM. *An. Acad. Brasil. Ciênc.*, **21** (*No.* 3) 199–203 (1949) *In English.*

Cocconi's results [Abstr. 3311 (1949)] indicating a change of mean free path of shower primaries with absorber thickness are explained in terms of charge exchanges occurring along the path of the primaries. E. P. GEORGE

537.591.15

1839. An investigation of the nature of the particles of special showers of cosmic rays. N. BIRGER AND L. EIDUS. *Dokl. Akad. Nauk, SSSR*, **65** (*No.* 6) 819–22 (1949) *In Russian.*

A counter-controlled cloud chamber was operated in a magnetic field of 12 000 gauss at an altitude of 3 860 m. Showers were studied with 20 cm Pb above the chamber. The size-frequency distribution of showers is reported. Electrons, mesons, protons and α-particles were identified among the shower particles. E. P. GEORGE

537.591.15

1840. The distribution of penetrating particles and high energy electrons in wide atmospheric showers. D. M. ALEKSEEV, G. T. ZATSEPIN AND I. G. MOROZOV. *Dokl. Akad. Nauk, SSSR*, **63** (*No.* 4) 375–7 (1948) *In Russian.*

5 counter trays of sensitive area 1 750 cm² were used at an altitude 3 860 m, with separations between extreme trays varying up to 60 m. 4 of the trays were screened with Pb up to 24 cm thickness. The results disagree with the hypothesis of the local production of penetrating particles in the absorbers. E. P. GEORGE

537.591.15

1841. Concerning the limit of wide atmospheric showers of cosmic rays. D. V. SKOBELTSYN. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 1) 45–8 (1949) *In Russian.*

Theoretical. Molière's calculations ["Kosmische Strahlung," Thesis, Berlin (1943) p. 24] together with the measured frequency of coincidences in widely separated trays of unshielded counters, are used to derive the frequency of electrons with energies $\sim 10^{18}$ eV at the top of the atmosphere. The result is 10× the figure obtained by extrapolation of the spectrum derived from Millikan's results. E. P. GEORGE

537.591.15

1842. Concerning the form of the correlation curves [decoherence curves] in Auger showers at large distances. D. V. SKOBELTSYN. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 2) 255–8 (1949) *In Russian.*

According to cascade theory, at distances $> r_1$, the characteristic scattering length (~ 100 m air), the frequency of coincidences in two counter trays should vary as $1/r^{5\cdot2}$. Experiments by Zatsepin employing separations up to 1 000 m show the dependence to be more like $1/r^{2\cdot7}$. As possible reasons for the discrepancy, the influence of the presence of mesons and nucleons in the showers, and the possibility of the existence of 2 or more cores at large distances, are discussed. E. P. GEORGE

537.591.15

1843. On the electronic component in extensive air showers. Y. FUJIMOTO, S. HAYAKAWA AND Y. YAMAMUCHI. Letter in *Progr. Theor. Phys.*, **4**, 381–2 (*July–Sept.*, 1949).

An earlier calculation [Abstr. 4855 (1949)] is improved by using analytical methods as far as possible and new constants. The results and suitable values of the constants are discussed. G. J. KYNCH

537.591.15

1844. Three-dimensional calculations of the cosmic-ray intensities. I. H. HASEGAWA AND H. KITA. Letter in *Progr. Theor. Phys.*, **4**, 376–7 (*July–Sept.*, 1949).

The number of downward moving mesons is calculated allowing for the angular spread using an apparent absorption coeff. instead of using a 1-dimensional model. A large reduction in the calculated intensity is claimed for this model. G. J. KYNCH

537.591.15

1845. A preliminary treatment of nucleon cascade. H. KITA AND H. HASEGAWA. Letter in *Progr. Theor. Phys.*, **4**, 371–2 (*July–Sept.*, 1949).

Diffusion equations are obtained assuming a definite collision cross-section A of a nucleus by a nucleon, that a constant fraction k of the energy is lost at each collision in meson production and power-law energy spectra for the protons and neutrons. If the constants are carried through the calculation, a reasonable value of k is possible only if A differs from the geometrical cross-section. G. J. KYNCH

537.591.3

1846. Cosmic-rays underground. I. S. HAYAKAWA AND S. TOMONAGA. *Progr. Theor. Phys.*, **4**, 287–97 (*July–Sept.*, 1949).

On the hypothesis that only μ-mesons can penetrate to great depths, it is shown that existing experimental material is not sufficient to distinguish between ranges for π-mesons (limiting the π–μ transition at high energies) of (*a*) ~ 125 gm cm^{-2} and, of (*b*), the thickness of the atmosphere or greater. J. G. WILSON

537.59..5

1847. A preliminary directional study of cosmic rays at high altitude. I. Apparatus and procedure. W. G. STROUD, J. SCHENCK AND J. R. WINCKLER. *Phys. Rev.*, **76**, 1005–11 (*Oct.* 15, 1949).

To study the effects of secondary particles on the

measurement of the primary directional intensity at high altitudes, a preliminary study has been carried out. Geiger counter telescopes at selected zenith angles from 0° to 90°, utilizing Pb filters up to 17 cm, have been sent up to 100 000 ft using constant-level Pliofilm balloons. Counting rates, temp., pressure and azimuthal orientation were radioed to the ground by means of a 15-channel f.m. telemetering system. This paper describes in detail the electronic and mechanical features of the apparatus. A.

537.591.5

1848. A preliminary directional study of cosmic rays at high altitude. II. Experimental results and interpretation. J. R. WINCKLER AND W. G. STROUD; T. J. B. SHANLEY. *Phys. Rev.*, **76**, 1012–18 (*Oct.* 15, 1949).

The zenithal distribution of particles at high altitudes observed with counter telescopes has been compared with simple calculations concerning the multiplicity and angular divergence of secondary particles. The observations are in agreement with a sharply collimated forward type of production event, and disagree with the wide angle type of production of hard secondaries. The azimuthal distributions and zenithal distributions indicate a nearly isotropic primary flux, in agreement with geomagnetic considerations at geomag. latitude 56°*N*. The effects of the atmosphere on directional asymmetry measurements at 13 g/cm² atmospheric depths are concluded to be small, especially if Pb filters of a few cm thickness are used. The number of low energy particles is small at this depth. A.

537.591.8

1849. On the penetrating, star-producing radiation. B. FERRETTI. *Nuovo Cim.*, **6**, 379–89 (*Sept.*, 1949) *In Italian.*

A model for the star-producing component of cosmic radiation is discussed. The behaviour of nucleons of not too high an energy is studied in some detail. Some consequences of the proposed model are compared with the experimental facts. A.

537.591.8

1850. On the proton-decay in cosmic ray stars. Y. FUJIMOTO AND Y. YAMAGUCHI. Letter in *Progr. Theor. Phys.*, **3**, 462–3 (*Oct.–Dec.*, 1948).

The number of low energy protons, in so far as it is > would be expected on an evaporation theory, is explained as the decay of nucleons with proton excesses [Abstr. 3645 (1947)]. G. J. KYNCH

537.591.8

1851. Star production by negative μ-mesons in a silver chloride crystal. H. G. VOORHIES AND J. C. STREET. *Phys. Rev.*, **76**, 1100–5 (*Oct.* 15, 1949).

An AgCl crystal has been used to detect μ-mesons which stop in the crystal or in some brass immediately below it. It is found that such mesons and their decay electrons produce pulses well above noise and with rise times of 0·2 to 0·35 μsec. On the basis of 79 decay events, the meson mean life is found to be $1{\cdot}9 \pm 0{\cdot}3$ μsec. By comparing the pulse height distribution for stopped mesons with the distribution for the hard cosmic-ray component, it is shown that the crystal response is ∝ energy loss for slow, heavily ionizing particles. During an experimental run 263 mesons stop. 40 are observed to decay, and it is calculated that 78 are negative mesons which stop in the crystal. It is first shown that, in general, nuclear capture of negative μ-mesons does not result in the production of stars in which the charged particles carry on the average ½ the meson rest energy. Further analysis shows that, if stars are produced, the average energy of the charged particles is but a very few MeV, probably < 3 MeV. 5 large pulses associated with stopped particles might be interpreted as star pulses, but some of these may be due to stopped protons. A.

537.591.8

1852. Further results on neutron production by cosmic-ray particles at sea level. R. D. SARD, A. M. CONFORTO AND M. F. CROUCH. *Phys. Rev.*, **76**, 1134–5 (*Oct.* 15, 1949).

Further measurements at sea level on neutrons coincident with charged cosmic-ray particles are reported. It is shown that the coincident neutrons are neither incident from the air nor produced in the neutron detector; they are produced in the Pb in the experimental arrangement used. The earlier evidence for neutrons associated with the stopping in Pb of charged particles filtered by 12·7 cm Pb is confirmed. Evidence is presented for a second effect-neutron production in Pb in some kind of penetrating ionizing event. These neutron-penetrating particle coincidences may well be related to those discovered by Tongiorgi in penetrating showers; their bearing on the interpretation of neutron-stopped particle coincidences is discussed. With increasing thickness of the Pb filter above the G–M tube telescope, the frequency of the latter is essentially constant, while the frequency of the "neutron showers" increases steadily. Intensity considerations indicate that the bulk of the neutron-stopped particle coincidences are due to μ-mesons stopped in the Pb; the neutron penetrating particle coincidences may well be due to incident nucleons. A very crude estimate of the average number of neutrons per stopped negative meson gives 2 or 3; the systematic errors are so uncertain that one can only conclude that the multiplicity is with high probability < about 5. A.

537.591.8

1853. Relative frequency of stars with differing numbers of prongs produced by cosmic rays in photographic plates at 29 000 m above sea level. M. M. ADDARIO AND S. TAMBURINO. *Nuovo Cim.*, **6**, 405–8 (*Sept.*, 1949) *In Italian.*

The plates were carried by balloon-sondes at 55°*N* geomagnetic latitude. The frequencies of *n*-pronged stars, per cm³ and per day, were found to be: $n = 3$, 506; $n = 4$, 454; $n = 5$, 229; $n = 6$, 189; $n = 7$, 120; $n = 8$, 116; $n = 9$, 88; $n = 10$, 56. The highest observed number of prongs was 24. The relative number of stars with large n is higher at 29 000 m than at 3 500 m. This is consistent with the hypothesis that the star-producing radiation consists of nucleons whose energy decreases as they penetrate the atmosphere. L. PINCHERLE

537.591.8

1854. Two kinds of very high energy cosmic-ray stars. L. LEPRINCE-RINGUET, F. BOUSSER, HOANG-TCHANG-FONG, L. JANEAU AND D. MORELLET. Letter in *Phys. Rev.*, **76**, 1273–4 (*Oct.* 15, 1949).

Two characteristic but contrasted large stars

obtained at 100 000 ft in Ilford G 5 emulsion are described: (1) 27 heavily ionizing tracks + 27 collimated minimum ionization tracks formed by a non-ionizing primary. The light tracks are considered to contain comparable numbers of protons and mesons; (2) 17 relativistic + 34 heavily ionizing tracks in star produced by a 12 BeV heavy nucleus of charge $14 < Z < 20$. The relativistic particles are not collimated, and since the energy per incident nucleon is of the order 0·5 BeV, the probability of meson production is small. The almost complete disintegration of the struck (Ag) nucleus is postulated.

J. G. WILSON

MAGNETISM 538

538.112 : 621.318.2

1855. On the perfect magnet. E. BRYLINSKI. *Rev. Gén. Elect.*, **58**, 315–20 (*Aug.*, 1949) *In French.*

The magnet considered is saturated and independent of any external field. The magnetic moment of a long thin round magnet is calculated from that of an atom. It is shown that the saturation induction of the best modern magnets is only 0·574× the theoretical limit. An attempt is made to calculate the flux density of the ideal magnet assuming the equivalent "annulation currents" of the spinning electron to align themselves like turns of a solenoid. Allowance is made for mutual inductance between these turns, but the method is shown to be liable to grave objections. The internal and external energy of the magnet is calculated with particular reference to the energy involved in demagnetization. S. C. DUNN (R)

538.114

1856. On the relation between Heisenberg's theory of ferromagnetism and that of Slater. K. YOSIDA. *Progr. Theor. Phys.*, **4**, 151–9 (*April–June*, 1949).

Analytical treatment shows that for equivalent results to Slater's theory, Heisenberg's theory must be generalized to include not only states with only one electron on one lattice-point. In particular the mean interaction energy between electrons with constant m quantum number is calculated on each theory and shown to be the same. The equivalence of the conditions for the occurrence of ferromagnetism on the two theories is also shown. C. E. WEBB

538.114

1857. A note on the theory of ferromagnetism. H. SHIMAZU. *Progr. Theor. Phys.*, **2**, 160–4 (*April–June*, 1949).

Heisenberg's and Slater's theories of ferromagnetism are compared using simple wave functions. It is shown that with a simple lattice model in which no two electrons with parallel spins occur in any individual cell, although this involves neglecting the spreading of the energy bonds, close agreement with Heisenberg's theory is obtained if Slater's treatment is modified to take account of the different probabilities of the occurrence of configurations with different energies. C. E. WEBB

538.114

1858. The collective electron theory of ferromagnetism. S. MIYAHARA. *Progr. Theor. Phys.*, **4**, 142–50 (*April–June*, 1949) *In Esperanto.*

An extension and generalization of the collective electron theory of ferromagnetism is developed on the basis of Slater's theory. From this general relations between magnetism and temperature are deduced, depending on the form of the state density function. The conditions for the appearance of the Langevin-function are also considered and the case of iron is specially discussed. A.

538.114

1859. On the conditions for the occurrence of ferromagnetism in metal compounds. J. H. GISOLF. Letter in *Physica*, **15**, 677–8 (*Sept.*, 1949).

Points out that the observed ferromagnetism of the ferrites with spinel structure is in accordance with the deduction that for the occurrence of ferromagnetism in metal compounds it is necessary, though not sufficient, that the lines of communication between the metal atoms which are in exchange interaction, form a three-dimensional network. On this basis only the ions in "tetrahedron holes" in the structure contribute to the ferromagnetism. A. E. DE BARR

538.122 : 537.533.72 : 621.317.42

1860. Electron optical observation of magnetic fields. L. MARTON AND S. H. LACHENBRUCH. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 409–28 (*Oct.*, 1949).

The electron optical analogue of the "Schlieren" method may be used to explore electromagnetic fields where conventional methods fail. Furthermore, a related shadow method, especially suitable for the quantitative evaluation of such fields, has been found. Properties of the Schlieren patterns produced by a magnet consisting of two point poles are predicted mathematically. An experimental Schlieren pattern, produced by a magnetized recording wire, is interpreted qualitatively and compared with a powder pattern. The related shadow method is applied to the magnetized wire. The experimental data agree well with theoretical formulae derived from this hypothesis and yield reasonable numerical values for the field strength and for the separation of the point poles to which each magnetized region is assumed equivalent. A.

538.221

1861. Magnetic viscosity in Mn–Zn ferrite. R. STREET AND J. C. WOOLLEY. Letter in *Proc. Phys. Soc., Lond. A*, **62**, 743–5 (*Nov.*, 1949).

A theory of magnetic viscosity [see Abstr. 384 (1950)] fits the experimental results on Mn–Zn ferrite. A. E. DE BARR

538.221

1862. Relation between the thermal expansion, the Curie temperature and the lattice spacing of homogeneous ternary nickel-iron alloys. J. J. WENT. *Physica*, **15**, 703–10 (*Sept.*, 1949).

The importance of more experimental data concerning the exchange energy in ferromagnetic alloys is pointed out. The Curie temp., the expansion anomaly below the Curie temp. and the lattice spacing of 15 only slightly different homogeneous ternary Ni–Fe alloys with about 50% Fe and 50% Ni

was measured. Between the change in Curie temp. and the change in the expansion anomaly between different alloys a close relationship exists. The value of this change in the Curie temp. depends upon the position of the third alloying element in the periodic system of elements with respect to the position of Ni in this system. There is no direct relation between the change in Curie temp. and the lattice spacing. A.

538.221

1863. Magnetic anisotropy of binary alloys of Ni. I. M. Puzeĭ. *J. Tech. Phys., USSR*, **19**, 653–60 (*June*, 1949) *In Russian.*

The anistropy constant K of alloys of Ni with up to 40% (atomic) Cu and 8% (atomic) Mo was found from measurements of the approach of polycrystal specimens to magnetic saturation. At − 183°C K was found to be a function only of the saturation intensity for all the alloys studied; this saturation intensity was a linear function of the atomic percentage of added metal, falling 5·5 times as fast for Mo as for Cu (in agreement with previous authors).

D. SHOENBERG

538.221

1864. Magnetic characteristics of an oriented 50 percent nickel–iron alloy. J. H. Crede and J. P. Martin. *J. Appl. Phys.*, **20**, 966–71 (*Oct.*, 1949).

538.221

1865. The coercive force of ferromagnetic powders. C. Guillaud. *C.R. Acad. Sci., Paris*, **229**, 818–19 (*Oct.* 24, 1949) *In French.*

Measurements on finely powdered Mn_2Sb alloy show a closely parallel variation with temp. of the coercive force and the magneto-crystalline energy, and confirm the importance of the magneto-crystalline energy in determining the coercive force of particles consisting of only a very small number of domains. C. E. WEBB

538.221 : 538.242

1866. Measurement of the gyromagnetic effect in iso-electronic ferromagnetic alloys. A. J. P. Meyer. *C.R. Acad. Sci., Paris*, **229**, 707–8 (*Oct.* 10, 1949) *In French.*

Measurements by the Einstein–de Haas method on 4 alloys of the Fe–Co–Ni group indicate a Landé factor, $g = 2{\cdot}0$ in all cases. The different atomic moments of alloys having the same mean number of electrons cannot, therefore, be attributed to an orbital moment of the 3*d* electrons. C. E. WEBB

538.221 : 539.185

1867. Detection of antiferromagnetism by neutron diffraction. C. G. Shull and J. S. Smart. Letter in *Phys. Rev.*, **76**, 1256–7 (*Oct.* 15, 1949).

Theory suggests that an antiferromagnetic substance, below its Curie point, should give rise to a measurable coherent scattering of neutrons. This is borne out by neutron diffraction experiments on MnO where, above the Curie point (80°K), only the normal crystalline diffraction peaks are observed (plus diffuse "magnetic" scattering). Below this point, however, strong magnetic reflections occur at positions not allowed on the basis of the normal unit cell. These reflections may be indexed on a "magnetic" unit cell which is twice as large as the chemical unit cell. J. THEWLIS

538.221 : 621.318.2.042.2 : 669.1

1868. Magnetic anisotropy in cold-reduced electrical sheet steel. A. E. De Barr. *Proc. Instn Elec. Engrs, Pt II*, **96**, 719–28 (*Oct.*, 1949).

The observed anisotropy of oriented polycrystalline Si–Fe sheet is discussed with reference to the result of crystal physics. It is shown that whilst the material can be regarded as homogeneous, e.g. for elasticity or magnetic torque, good agreement is obtained between theory and experimental results on the oriented sheet. An equivalent model aggregate described simulates very closely the observed properties of the sheet. The application of the domain theory of ferromagnetism to the anisotropy of magnetic properties is discussed, and it is suggested that the problems arising might be explained by considering the actual domain configuration of the material. Experimental results on hysteresis loss, permeability, magnetostriction, etc., for oriented sheet are considered in relation to the domain changes taking place during magnetization. The more complex phenomena occurring during a.c. magnetization are considered in relation to the simpler magnetic properties discussed earlier. A.

538.224

1869. The magnetic susceptibility of organic compounds. S. Broersma. *J. Chem. Phys.*, **17**, 873–81 (*Oct.*, 1949).

With the object to obtain new data for the statistical analysis of hydrocarbon mixtures, measurements on diamagnetic organic compounds at room temperature have been performed. The precision was of the order of 1 per mil (10^{-3}) of the diamagnetic effect. A.

538.224 : 536.48

1870. The magnetic behaviour of copper potassium Tutton salt and manganese ammonium Tutton salt at very low temperatures. M. J. Steenland, L. C. van der Marel, D. de Klerk and C. J. Gorter. *Physica*, **15**, 906–12 (*Oct.*, 1949).

A first survey has been given of the thermodynamic temps. reached by adiabatic demagnetization of these salts. A.

538.24

1871. On the propagation of large Barkhausen discontinuities in Ni–Fe alloys. L. J. Dijkstra and J. L. Snoek. *Philips Res. Rep.*, **4**, 334–56 (*Oct.*, 1949).

The propagation of the Bloch boundary between two macro-domains under the influence of an external magnetic field H is investigated for Ni–Fe wires of the composition 60–40 and 50–50 subjected to a tensile stress. The quantities involved are the axial rate of propagation v and the effective length λ of the discontinuity. In a satisfactory way v can be represented by the Sixtus–Tonks relation: $H - H_0 = A^{-1}v$. The friction constant A^{-1} is independent of H and $\propto$ the abs. temp. T in a region from − 180°C up to 100°C. The value of A^{-1} tends to increase with an increasing amount of cold work and increasing magnitude of the induced eddy currents. The ratio $\lambda/a = K$, in which a is the radius of the wire, shows an approx. constant behaviour with regard to variations in the temp., amount of cold work, magnitude of the eddy currents and chemical composition in the range investigated. A review is given of the various factors determining the shape of the boundary and

...e rate of propagation v. The experimental results ...ad to the concept that the movement of the Bloch ...oundary is impeded by two causes of different origin, ...he being the eddy-current effect, the other probably spin-relaxation effect. A.

538.245

1872. Influence of tensile stressing on the saturation magnetization of Fe–Ni alloys in the Invar range. K. P. Belov. *J. Tech. Phys., USSR*, **19**, 1032–40 (*Sept.*, 1949) *In Russian.*

An increase of the saturation value of the magnetization owing to tensile stressing was observed for all the tested alloys, most marked in the Curie region. The experimental results agree with the measurements of the temp. relation of the magnetostriction of the para-process of these alloys. An explanation of the phenomenon is attempted on Heisenberg's theory, but it is stressed that owing to the complexity of the problem it cannot be more than tentative. B. F. KRAUS

538.245

1873. The relation between the ferromagnetism of thin Fe-, Co- and Ni-plates and their thickness. A. Drigo and M. Pizzo. *Nuovo Cim.*, **6**, 327–36 (*Sept.*, 1949) *In Italian.*

Preliminary results are given of experiments on the hysteresis cycle presented by plates of thickness between 10^{-4} and 10^{-7} cm. Although Barkhausen discontinuities disappear, ferromagnetic properties are still detectable at the smallest thicknesses, due probably to rotations produced by the magnetizing field against the anisotropy forces. L. PINCHERLE

538.245

1874. On the magnetic structure of highly coercive alloys. I. Some peculiarities of the magnetization curves and hysteresis loops of alnico and vicalloy highly-coercive alloys. L. A. Shubina and Y. S. Schuur. *J. Tech. Phys., USSR*, **19** (*No.* 1) 88–94 (1949) *In Russian.*

To determine the physical mechanism of magnetization in "hard" ferromagnetic materials, experiments were made on 2 highly-coercive alloys, which were given a magnetically-anisotropic structure by heating or cold-working in different magnetic fields. The results justify the assumption that the ferromagnetic phase develops in a series of thin strata divided by diamagnetic layers, each stratum forming a separate domain. Magnetization nuclei are absent in these domains and displacement of the boundaries is impossible; technically, magnetization is possible only by rotation of the field. INDEX AERONAUTICUS

538.245 : 537.312.8

1875. On the magnetic structure of highly-coercive alloys. II. The influence of thermomagnetic treatment on the electrical resistance of alnico highly coercive alloy. V. I. Drozhzhina and Others. *J. Tech. Phys., USSR*, **19** (*No.* 1) 95–9 (1949) *In Russian.*

Experiments made for the further investigation of the nature of magnetization in highly-coercive, "hard" ferromagnetic materials, indicate that the magnetic anisotropy resulting from thermo-magnetic treatment, is due to anisotropy in the structure of the alloy. INDEX AERONAUTICUS

538.245 : 538.652

1876. On the magnetic structure of highly-coercive alloys. III. Curves of magnetostriction of the highly-coercive alloys alnico and vicalloy. D. A. Shturkina and Y. S. Schuur. *J. Tech. Phys., USSR*, **19** (*No.* 2) 235–42 (1949) *In Russian.*

An experimental investigation into the development of longitudinal and transverse magnetostriction in alnico and vicalloy with different magnetic textures. The results obtained can be explained on the assumption of a structure of finely-dispersed ferromagnetic particles separated by a non-magnetic matrix, each particle forming a separate domain. Under certain conditions of working and heat treatment, these become oriented, leading to anisotropy of the magnetic properties. INDEX AERONAUTICUS

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3 : 530.145

Interaction of electrons and an electromagnetic field treated by analytic continuation. *See Abstr.* 1489

538.3 : 621.3.01

1877. On the mathematical theory of electrodynamic phenomena deduced entirely from experience. V. Bianchi. *Elettrotecnica*, **26**, 220–46 (*May*, 1949) *In Italian.*

The author claims to have formulated a new theory of electrodynamic phenomena in which the action of one electrical circuit on another is reduced to the computation of the action between elements of the circuits. (Action at a distance). [These formulae, which are taken as fundamental, do not appear to be novel in any way, but can be readily deduced from current theory]. Their use is illustrated by numerous simple examples. V. C. A. FERRARO

538.3 : 621.3.011.2

1878. On the intrinsic impedance of free space. E. Brylinski. *C.R. Acad. Sci., Paris*, **228**, 666–7 (*Feb.* 21, 1949) *In French.*

The intrinsic impedance of free space is given by $Z_0 = \mathscr{E}/\mathscr{H} = \sqrt{\mu_0/\varepsilon_0}$ where $\mathscr{E}$ and $\mathscr{H}$ are the electric and magnetic field strengths and μ_0 and t_0 are the permeability and permittivity *in vacuo*. The value of Z_0 deduced from this equation is 30 Ω in the MKSA units and 477 Ω in the rationalized system. As the ohm has the same value in both systems one value must be rejected. From an analogy with the twin open-wire line it is deduced that the 30 Ω value is correct. W. T. BLACKBAND (R)

538.3 : 621.3.011.2

1879. The intrinsic impedance of space. G. W. O. Howe. *Wireless Engr*, **26**, 281–3 (*Sept.*, 1949).

Brylinski [previous Abstr.] concluded that the intrinsic impedance of free space was 30 Ω. The impedance is 377 Ω and is independent of the units used as it is the ratio of E/H. If E is in V/cm and H is in oersteds, H must be converted into A/cm in order to obtain a resistance in Ω. This conversion introduces the factor $4\pi/10$. It is claimed that the example quoted by Brylinski is irrelevant. There is confusion in the meaning of the intrinsic impedance

of free space. This confusion goes back to Heaviside from whose works quotations are made. The concept of the intrinsic impedance is used in the calculation of the Z_0 of an inverted cone. W. T. BLACKBAND (R)

538.311 : 621.318.33

1880. The Uppsala electromagnet. O. SNELLMAN AND E. BURGE. *J. Sci. Instrum. Phys. Ind.*, **26**, 331–5 (*Oct.*, 1949).

The electromagnet at the Institute of Physical Chemistry described can produce a field of 68·5 kilo-oersteds with pole-face of 0·5 cm dia. and a gap of 0·2 cm. A.

538.54

1881. Electromagnetic induction in a rotating sphere. E. C. BULLARD. *Proc. Roy. Soc. A*, 413–42 (*Dec.* 7, 1949).

An account is given of the induction of electric currents in a rotating conducting sphere surrounded by a stationary conducting shell. Both induction by a constant field and the freely decaying modes are treated. The associated mechanical couples are discussed. The results of most interest are those concerning the toroidal magnetic fields. These fields are entirely confined to the interior of the conductor and may play an important part in terrestrial magnetism. Induction in an oscillating sphere is briefly discussed. A.

538.56 : 535.43

1882. Contributions to the theory of diffraction of electromagnetic waves by spherical particles. II. T. LJUNGGREN. *Ark. Fys.*, **1**, *Paper* 1, 1–18 (1949) *In English.*

The method given in Part 1 [Abstr. 550 (1949)] of carrying out the numerical evaluation of the formulae arising in this problem is here applied in greater detail, and its use in the experimental determination of the size of droplets in a mist is discussed.

P. M. DAVIDSON

538.566 : 534.24 : 621.396.11

1883. Reflection of spherical waves on "weak" separating surfaces. L. BREKHOVSKIKH. *J. Tech. Phys., USSR*, **18**, 473–82 (*April*, 1948) *In Russian.*

The field of acoustic or radio waves from a point source above a plane separating surface is investigated for the special case in which the properties of the two media separated by the surface are not very different from one another. Limitations of the existing theories are shown. B. F. KRAUS (R)

538.566 : 534.24 : 621.396.11

1884. Reflection of spherical waves on the plane separation of two media. L. BREKHOVSKIKH. *J. Tech. Phys., USSR*, **18**, 455–72 (*April*, 1948) *In Russian.*

A point source of acoustic or electromagnetic waves is assumed to be situated above the plane of separation of two media. The calculation is effected by expanding the general solution in power series in terms of $1/k_0R$. Formulae for practical calculation of the Hertz vector in the electromagnetic case, and the acoustic potential in the acoustic case are obtained, and these are valid for any position of wave source and receiver, respectively, above the separating plane. A new type of "lateral" wave is described and shown to be important in a number of special cases. Detailed discussion of the solution deals further with the application of the methods of geometrical optic the problem and shows its limitations. B. F. KRAUS

538.566 : 535

1885. Total reflection of an e.m. wave with meta reflection of the evanescent wave. S. GIBELL *Nuovo Cim.*, **6**, 344–59 (*Sept.*, 1949) *In Italian.*

The phase shifts at total reflection of the wa with the electric vector respectively parallel and pe to the plane of incidence are altered by differ amounts when a metal plate is introduced in second medium, parallel to the refracting surface as to reflect back the evanescent waves. Formu are given for the phase shifts as functions of distance between the plate and the surface, wh were verified by experiments with cm waves.

L. PINCHE

538.566 : 621.396

1886. The time of propagation of electro-magne waves in the troposphere. A contribution to a the of precise navigation. G. ECKART. *Rech. Aéronau* **9**, 43–6 (*May–June*, 1949) *In French.*

The object is to calculate the corrections wh must be applied, due to the influence of the varia optical density of the troposphere. At the great distances and altitudes to be considered, this giv the range of the aircraft from a ground stati within 100 m. With such readings to two statio the position is given with a sufficient degree accuracy. INDEX AERONAUTIC

538.566 : 621.396.6

1887. Addendum: Analysis of the metal-strip del structure for microwave lenses. S. B. COHN. *J. App Phys.*, **20**, 1011 (*Oct.*, 1949).

See Abstr. 4896 (1949). Numerical values certain graphs are presented.

538.566

1888. Lateral deviation of radio waves reflected the ionosphere. *Dep. Sci. Industr. Res., Radio Re Rep.* (*No.* 19) 32 *pp.* (1949).

A comprehensive account of observations on th bearing deviations of radio waves reflected at th F_2-layer, made in Great Britain in the period 1938–4 using spaced-loop direction finding equipmen (frequency range 6–15 Mc/s.) W. J. G. BEYNO

538.566.2 : 621.396.1

1889. Tropospheric effects in short and mediu radio wave propagation. W. J. G. BEYNON. Letter i *Nature, Lond.*, **164**, 711 (*Oct.* 22, 1949).

Signal amplitude measurements suggest tropo spheric influences on radio-wave propagation a wavelengths in the range 60–300 m. A

538.566.3 : 621.396.1

1890. Application of the magneto-ionic theory t radio waves incident obliquely upon a horizontally stratified ionosphere. H. G. BOOKER. *J. Geophys Res.*, **54**, 243–76 (*Sept.*, 1949).

A study is made of the propagation of wave packets incident obliquely upon a slowly varyin plane-stratified ionosphere, allowing for the ful effect of the earth's magnetic field. Propagation of magneto-ionic component is described in terms of th vertical component q of the phase-propagatio vector, so as to avoid using a refractive index whic depends in a complicated way on an unknown angl of refraction. The fundamental formula of the theor

an algebraic quartic equation for q, the coeffs. in hich depend on electron-density N, wave-frequency, irection of earth's magnetic field, and direction of cidence upon the ionosphere. The 4 roots of the uartic for q correspond to the upgoing/downcoming rdinary/extraordinary magneto-ionic components. t is shown that, to plot the 4 roots of q as a function f N for fixed values of the other parameters, it is asier to restate the fundamental formula as a cubic quation for N as a function of q. Using this cubic quation, simple limiting curves between which the ctual curves necessarily lie are deduced, thereby acilitating plotting in a particular case. Methods for nass-production of such propagation-curves are levised but not applied on a large scale. Formulae or attenuation, lateral deviation, horizontal range, nd equivalent paths of magneto-ionically split wave-packets are derived and illustrated graphically. The amount to which a wave-packet can be permanently deviated out of its plane of incidence by the earth's magnetic field can be extremely large, but probably not in cases of practical importance in commercial radio communication. A.

538.567.3 : 621.385.833

1891. Amplification of e.m. waves by interaction of electron streams moving in crossed electric and magnetic fields. R. Warnecke, O. Doehler and W. Kleen. *C.R. Acad. Sci., Paris*, **229**, 109–10 (*Oct.* 10, 1949) *In French.*

The motion of electrons in crossed electric and magnetic fields is considered for the case when $eE = eu_0B$ i.e. rectilinear propagation. It is found that when two such beams interact with an e.m. wave the density modulation is zero, but the thickness of the beams and the spacing from the walls of the guide varies. The propagation constant has two complex conjugate solutions, one increasing, the other diminishing. The existence of such phenomena may explain anode current in magnetrons when the magnetic field is well above the critical value.

A. H. W. BECK

MAGNETIC EFFECTS 538.6

538.613 : 535.58 : 535.563

Production of intense magnetic fields by impulses. Application to phenomena of rotary polarization and magnetic birefringence. *See Abstr.* 1688

538.652 : 538.245

Magnetostriction of alnico and vicalloy. *See Abstr.* 1876

538.742

1892. A static low temperature method for determining small residual fields accurately in magnetic experiments. W. F. Giauque and J. W. Stout. *J. Amer. Chem. Soc.*, **71**, 3486–7 (*Oct.*, 1949).

The method utilizes the electrical resistance of a Bi coil at liquid He temp. It avoids the use of ferromagnetic materials, flip-coils and other rotating or oscillating devices, which are considered to provide undesirable complications during adiabatic demagnetization experiments at temps. below 1°K. A.

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

1893. On the disordering of solids by action of fast massive particles. F. Seitz. *Disc. Faraday Soc.* (*No.* 5) 271–91 (1949).

Properties of solids will be markedly altered by displacement of 10% of their atoms. Attempts are made to determine the effectiveness of different massive particles in producing such displacements. Particle motion is described by the energy (ε) an electron of equal velocity would possess. Considerations of energy partition among ionization and elastic collision processes show that the former predominate until particle energies (ε) are below the binding energies of valence electrons, when elastic collisions prevail. Estimates are made of the number of displacements produced by different particles in solids such as Be, diamond, graphite, Si and Ge. Elastic collisions occur in diamond at 2·5 eV compared with 0·1–0·5 eV in other solids, resulting in 154 and about 50 displacements respectively due to a single 5 MeV α-particle. The difference is less marked for protons. A dose of 1 coulomb/cm² of 20 MeV protons in a layer of solid 1 mm thick will cause 10% disorder. This dose is easily attainable in practice. The probable effects of neutrons (2 MeV) and fission fragments in producing displacements are also estimated. Although the discoloration of insulators is usually due to ionization processes, the green coloration of diamond, due only to α-particles, is probably due to atomic displacement or the intense local heating effects of elastic collisions. A note added in proof indicates that the disordering of Cu–Au alloys by neutrons is mainly due to the indirect thermal effects of elastic collisions rather than to direct displacements. G. F. J. GARLICK

539.11 : 532.7 : 531.19

1894. Quasi-chemical method in the statistical theory of regular mixtures. Y.-Y. Li. *Phys. Rev.*, **76**, 972–9 (*Oct.* 1, 1949).

The quasi-chemical equations in the statistics of "regular" mixtures are deduced by assuming non-interference among local configurations. This method is capable of yielding higher and higher approximations by choosing a larger group of lattice sites as the local configuration under consideration. The comparative accuracy of different approximations can be judged by a simple criterion. Further applications to ferromagnetism and to the order-disorder transition in alloys, and their results are discussed. Equations for ternary mixtures or mixtures of even more components are given. The asymmetry of solubility of one solute in two immiscible solvents and the order effect of Ag_2HgI_4 serve as the interesting examples of the ternary case. A.

539.11 : 539.4.01

1895. On the theory of strength of quasi-isotropic solids. R. Fürth. *Phil. Mag.*, **40**, 1227–33 (*Dec.*, 1949).

It is shown that Bragg's theory of the strength of metals and the author's thermodynamic theory of

strength, can be related to each other. These theories can also be linked with recent theoretical ideas of Born and experimental results by Wood on the broadening of X-ray lines of metals. Some implications of the concept of an "intrinsic block structure" of crystal lattices are discussed. L. S. GODDARD

MOLECULAR STRUCTURE 539.13

539.13 : 539.27

1896. Tables of interatomic distances and molecular configurations obtained by electron diffraction in the gas phase. P. W. ALLEN AND L. E. SUTTON. *Acta Cryst.*, **3** (*No.* 1) 46–72 (1950).

In this compilation are tabulated all available results of investigations of the molecular structures of substances by study of the diffraction of electrons by their vapours. A substantial fraction of these is as yet unpublished. The total number of substances described is 500. Results obtained by other methods of investigation of structure in the gas phase are also given for direct comparison, where available. A.

539.132

1897. Notes on the validity and application of the method of molecular orbitals. C. A. COULSON AND H. C. LONGUET-HIGGINS. *Phil. Mag.*, **40**, 1172–7 (*Nov.*, 1949).

A partial explanation is given of the experimental fact that the method of molecular orbitals accounts quite well for the ground state of various systems. A method for calculating charges and bond orders when certain molecular orbitals are degenerate is outlined. L. S. GODDARD

539.132

1898. The electron pairing theory of the structure of conjugated hydrocarbons. W. MOFFITT. *Proc. Roy. Soc. A*, 487–99 (*Dec.* 7, 1949).

The electron pairing theory of molecular structure has been extended in its application to conjugated hydrocarbons. Formulae for calculating internuclear distances, force constants and interaction constants are derived. These appear to give rather better results than the already successful molecular orbital theory. The interaction of 2 conjugated systems is discussed, and it is shown how the conjugating power of a hydrocarbon residue may be correlated with its residual affinity. A

539.132

1899. Calculations of the lower excited levels of benzene. C. C. J. ROOTHAAN AND R. G. PARR. *J. Chem. Phys.*, **17**, 1001 (*Oct.*, 1949).

539.132

1900. Developments in the theory of the secular equation for molecular vibrations. P. TORKINGTON. *J. Chem. Phys.*, **17**, 1026–36 (*Nov.*, 1949).

A general solution for the secular equation is obtained, giving the force constants and normal coordinates, for any molecule, in terms of the fundamental vibration frequencies and molecular constants. The solution is based on the reduction of the secular determinant to Jacobian canonical form; it is shown to have a simple physical interpretation. Methods are developed which enable adjustments to be m to the standard solution as required. The theor fully illustrated by several worked examples.

539.

1901. Energy levels and thermodynamic funct for molecules with internal rotation. III. Compo rotation. J. E. KILPATRICK AND K. S. PITZ *J. Chem. Phys.*, **17**, 1064–75 (*Nov.*, 1949).

A method is given for calculating the elements the kinetic energy matrix for rotation for any molec The treatment includes the effects due to any num of linked rotating groups, balanced or unbalanc In a simple case these equations reduce to the simp ones of the two previous papers of this series [Abs 2355 (1946)]. This rotational matrix is then cc verted into the matrix of the internal rotations. T reduced moments of inertia that form the latter then used with the methods of the previous papers calculate energy levels and thermodynamic functio

539.132 : 535.3

Vibration-rotation bonds of allene. *See Abstr.* 16

539.132 : 535.3

Vibration spectra of hydrocarbon molecules. Skeletal frequencies in certain branched paraffin *See Abstr.* 1649

539.132 : 548

1902. Molecular rotation in sodium cyanide an sodium nitrate. L. A. SIEGEL. *J. Chem. Phys.*, 1 1146–50 (*Nov.*, 1949).

An attempt has been made to decide between th Pauling and Frenkel hypotheses for group disord in crystals on the basis of X-ray diffraction data Measurements of the line intensities of NaCN showe that no decision could be reached between two mode involving complete spherical rotation and a tetra hedral distribution of equilibrium positions. Th 220 line was found to possess an anomalously larg variation of intensity with temp. A new rhombo hedral form of NaCN was found which can b produced only by quenching the cubic form from th vicinity of 300°c. The cubic and rhombohedra forms coexist from 20°c to 80°c. An ordere structure has been proposed for the rhombohedra phase. The diffuse scattering from a single crystal o $NaNO_3$ has been studied, and a diffuse maximum ha been found which is believed to be a result of grou disorder. This maximum shows a strong angula dependence which is incompatible with the prediction of the rotation theory. The data fit a twofold dis order model for the NO_3 groups, provided that th positions have an aragonite-type of co-ordination wit the surrounding Na atoms, rather than the calcit co-ordination found in the ordered structure. A

539.13

1903. The determination of the molecular structur of bromosilane by microwave measurements. A. H SHARBAUGH, J. K. BRAGG, T. C. MADISON AN V. G. THOMAS. Letter in *Phys. Rev.*, **76**, 1419 (*Nov.* 1949).

539.13

1904. Ionic character and the dipole moment chemical bonds. Calculations of the dipole moment HCl. D. Z. ROBINSON. *J. Chem. Phys.*, **17**, 1022– (*Nov.*, 1949).

539.133

1905. The moment of inertia and electric dipole moment of CsF from radiofrequency spectra. J. W. TRISCHKA. *Phys. Rev.*, **76**, 1365–8 (*Nov.* 1, 1949).

The electric resonance method of molecular beam spectroscopy was used to obtain spectra resulting from induced changes in the space-quantization of the rotational state $J = 1$ of CsF in a homogeneous electric field. An analysis of the spectra for several values of the field intensity and for 2 different vibrational states gave the following molecular constants: $I_e = (151 \pm 6)10^{-40}$ g cm^2, $\mu_e = (7{\cdot}88 \pm 0{\cdot}17)10^{-18}$ e.s.u., $B_e = (185 \pm 7)10^{-3}$ cm^{-1}, $\alpha_e = (1{\cdot}85 \pm 0{\cdot}19)10^{-3}$ cm^{-1}, $r_e = (2{\cdot}34 \pm 0{\cdot}05)10^{-8}$ cm, $\omega_e = 770 \pm 30$ cm^{-1}. I_e is the moment of inertia, μ_e is the electric dipole moment, B_e and α_e are rotational constants, r_e is the internuclear distance and ω_e is the vibrational constant. A.

539.133

1906. Molecular dipole moments and Stark effects. I. Stark effects on symmetric top molecules with nuclear quadrupole coupling. W. LOW AND C. H. TOWNES. *Phys. Rev.*, **76**, 1295–9 (*Nov.* 1, 1949).

The hyperfine structure of rotational levels of a symmetric top molecule in which one nucleus has an electric quadrupole moment is derived for weak, strong and intermediate fields. Intensities of the hyperfine components are discussed. Solution of a second-order secular equation is shown to suffice for the evaluation of dipole moments from microwave spectra. A sample calculation is given for nuclear spin of $\frac{3}{2}$ and $J = 1 \rightarrow 2$ transition. A.

ATOMIC STRUCTURE . ISOTOPES 539.15

539.151 : 538.3

1907. The electromagnetic shift of energy levels. O. HARA AND T. TOKANO. Letter in *Progr. Theor. Phys.*, **3**, 316–17 (*July–Sept.*, 1948).

The shift in the levels is calculated using a canonical transformation of the Hamiltonian. A divergent term arising from the transformed external potential is ignored as a renormalization term and the result of Bethe is obtained [Abstr. 3608 (1948)]. G. J. KYNCH

539.152

1908. Notes on the *j–j* coupling shell model. E. FEENBERG. *Phys. Rev.*, **76**, 1275–8 (*Nov.* 1, 1949).

A study of the nuclear shell model based on the hypothesis of strong spin-orbit coupling yields a number of interesting results for even-even and odd-odd nuclei. To secure simple relations all calculations are based on the extreme limiting situation of complete *j–j* coupling. Maximum symmetry in the space wave function and *j–j* coupling are generally in sharp conflict. On occasion there is no conflict and then the consequences of the *j–j* coupling model are found to agree with experiment (notably the spin and magnetic moment of B^{10} and the sign of the magnetic moment of K^{40}). The *j–j* coupling model yields good results for the magnetic moments of N^{14} and Ne^{22}, but in both cases the agreement may be illusory because the computed moments are nearly independent of the amount of singlet wave function in the representation of the ground state. Also the model favours $I = 5$ for the ground state of Na^{22}. A.

539.152.1

1909. The existence of stable nuclei as related to the principle of regularity and continuity of series and the ends of nuclear shells. W. D. HARKINS AND M. POPELKA, JR. Letter in *Phys. Rev.*, **76**, 989–91 (*Oct.* 1, 1949).

539.152.1

1910. Nuclear shell structure. E. FEENBERG AND K. C. HAMMACK. *Phys. Rev.*, **75**, 1877–93 (*June* 15, 1949).

Closed shells are indicated by properties of nuclei with certain Z, $A–Z$; these numbers have a correspondence with the degeneracy of energy levels for free particles in a rectangular well, with a central depression for N or $Z \leqslant 20$ and a central elevation for heavy nuclei where coulomb repulsion reduces the central particle density. In the free particle model certain levels are displaced upwards by the central elevation, but the empirical closed shell numbers are not completely explained; a shell model can be made to fit by arguments based on configuration interaction. The model is supported by measured spins and moments of nuclei consisting of nearly closed shells, especially odd nuclei with an odd particle or hole, which usually determines the state of the nucleus; this is checked for consistency with the spins and moments. Isomerism can be correlated with crossing or closeness of levels in the shell model; possible pairs of ground and isomeric states are assigned to various transitions; spins, moments and parity help to decide the preferred configurations and to add detail to the model. β-transitions are classified allowed or forbidden using calculated *ft*-values. The configurations of parent and daughter determine their parity and possible spin values. The consistency of the classification with the possibilities of the shell model is investigated, using Gamow–Teller selection rules. Ambiguity of spin in parent or daughter is often lessened. No trend of *ft* with A for allowed (unfavoured) transitions is shown for $19 \leqslant A \leqslant 140$. T. G. PICKAVANCE

539.152.1

1911. On closed shells in nuclei. II. M. G. MAYER. Letter in *Phys. Rev.*, **75**, 1969–70 (*June* 15, 1949).

The assumption of strong spin-orbit coupling, increasing with angular momentum leads to level assignment different from those of Feenberg [Abstr. 1910 (1950)] or Nordheim [Abstr. 5604 (1949)], and with a square well provides agreement with experimental facts, with very few exceptions. The levels of a square well are tabulated with shell grouping and numbers of particles per shell; another table lists the known spins and orbital assignments (where known unambiguously) for even-odd nuclei up to 83. The prevalence of isomerism near the end of a shell (discussed by Feenberg and Nordheim) is implicit in this assignment, since here levels with greatly differing spins are adjacent. T. G. PICKAVANCE

539.152.1

1912. Note on proposed schemes for nuclear shell models. E. FEENBERG, K. C. HAMMACK AND L. W. NORDHEIM. Letter in *Phys. Rev.*, **75**, 1968–9 (*June* 15, 1949).

The relations between 3 recent papers on nuclear shell models (Feenberg and Hammack [Abstr. 1910 (1950)], Nordheim [Abstr. 5604 (1949)] and Mayer [Abstr. 1911 (1950)]) are explained. Feenberg and Hammack rearrange levels by elevating orbits with radial nodes (e.g. 2*s*, 3*p*, 4*d*); Nordheim's rearrangement is in the opposite direction; Mayer retains the level distribution of a simple well but assumes very strong spin-orbit coupling for high angular momenta. All these schemes correlate the shell model with observed spins and moments. T. G. PICKAVANCE

539.152.1

1913. Nuclear quadrupole moments and shell structure. R. D. HILL. Letter in *Phys. Rev.*, **76**, 998 (*Oct.* 1, 1949).

A table of the known quadrupole moments, Q, of nuclei, with the nuclear configuration of the unfilled shells, and the sign of the resultant Q on the nuclear shell model [Abstr. 1911 (1950)]. The agreement obtained is very satisfactory.

A. O. STANESBY

539.152.1

1914. Interpretation of the "special" [ausgezeichneten] nucleon numbers of nuclear structure in terms of a [shell] model. J. H. D. JENSEN, H. E. SUESS AND O. HAXEL. *Naturwissenschaften*, **36** (*No.* 5) 155–6 (1949) *In German.*

An anharmonic oscillator model of the nucleus in which spin-orbit coupling leads to strong term splitting. [See Abstr. 7193 (1949)]. A. O. STANESBY

539.152.1

1915. The interpretation of the "special" [ausgezeichneten] nuclear numbers in nuclear structure. II. H. E. SUESS, O. HAXEL AND J. H. D. JENSEN. *Naturwissenschaften*, **36** (*No.* 5) 153–5 (1949) *In German.*

Continuation of Abstr. 7190 (1949) covering nuclear spins, magnetic moments, odd-odd nuclei and frequency of occurrence of nuclear isomers.

A. O. STANESBY

539.152.1

1916. The energy level density and partition function of nuclei. D. TER HAAR. *Phys. Rev.*, **76**, 1525–6 (*Nov.* 15, 1949).

In this paper the nuclear energy level densities given by van Lier and Uhlenbeck [*Physica*, **4**, 531 (1937)] and by Bohr and Kalckar [*K. Danske Videns. Selsk. Mat.-fys. Medd.* (*No.* 10) **14** (1937)] are compared with those given by Wergeland [*Fra Fysik. Verden* (1945) *p.* 223]. It is shown that Wergeland's formula agrees slightly better with observational data. Wergeland's energy level density is then used to calculate the partition function of nuclei at a temp. of 1 MeV since this partition function enters into a discussion of the equilibrium theory of the origin of the chemical elements. A.

539.152.1

1917. Atomic nuclear models and beta decay. S. JNANANADA. *J. Sci. Industr. Res.*, **8**, 397–413 (*Oct.*, 1949).

539.152.1 : 53

1918. On the existence of light nuclear mes M. SASAKI, S. NAKAMURA AND S. HAYAKA Letter in *Progr. Theor. Phys.*, **3**, 454–5 (*Oct.–D* 1948).

It is suggested that two mesons interact w nucleons, one being a light meson of mass ~ 150 decaying into an electron. In this way a long ra force and a large quadrupole moment can be obtain G. J. KYN

539.15

1919. Precise measurement of the gyromagne ratio of He^3. H. L. ANDERSON. *Phys. Rev.*, 1460–70 (*Nov.* 15, 1949).

The gyromagnetic ratio of He^3 was compared that of H_2 gas by the magnetic resonance meth with the result $|\gamma(He^3)|/|\gamma(H_2)| = 0{\cdot}7617866$ $0{\cdot}0000012$. To obtain the nuclear gyromagnet ratios, a diamagnetic correction must be made whi raises this by approximately 38 parts in 10^6 $|\gamma_{He^3}|/|\gamma_p| = 0{\cdot}761815$. Intensity measuremen were consistent with a spin of $\frac{1}{2}$. In nuclea magnetons, the magnetic moment $\mu_{He^3} = (-)2{\cdot}1281$ based on the value $\mu_p = 2{\cdot}79353$ obtained by Tau and Kusch. The negative sign has not yet bee verified.

539.152.

1920. The nuclear gyromagnetic ratio of V^{51} W. D. KNIGHT AND V. W. COHEN. *Phys. Rev.*, 76 1421 (*Nov.* 1., 1949).

The resonance frequency for V^{51} was compared t that for Na^{23}, in a mixture of V_2O_5, NaCl, and dilut HCl, in a fixed magnetic field, using a recording r.f spectrometer. The magnet current was electronically stabilized to approximately 1 part in 10^5. The ratio of the uncorrected g-values is: $g(V^{51})/g(Na^{23}) =$ $0{\cdot}99394 \pm 0{\cdot}00003$. After making a diamagnetic correction of 0·171%, $g(V^{51}) = 1{\cdot}4713 \pm 0{\cdot}0003$ nuclear magnetons. Using the probable value 7/2 for the nuclear spin, the nuclear magnetic moment $\mu(V^{51}) = 5{\cdot}150$ nuclear magnetons. J. HUGHES

539.152.2

1921. Nuclear moments. F. BITTER. *Nucleonics*, **5**, 16–26 (*Oct.*, 1949).

A short survey of the quantities involved in the description of atomic nuclei, in particular the angular momentum quantum numbers and electrical and magnetic moments. The measurement of these quantities is described briefly and their values in H^2, H^3, He^3 and more complex nuclei are explained approximately. A comparison of ratios of moments of isotopic pairs, measured accurately by resonance methods, with those estimated from hyperfine structure may lead to information on the distribution of nuclear magnetization. The relationship between size and shape of a nucleus and its electric quadrupole moment is given and the ellipticities of a number of nuclei are deduced from observed quadrupole moments. L. R. SHEPHERD

539.152.2

1922. Erratum: Determination of nuclear gyromagnetic ratios. I. J. R. ZIMMERMAN AND D. WILLIAMS. Letter in *Phys. Rev.*, **76**, 1264 (*Oct.* 15, 1949).

See Abstr. 424 (1950). Typographical error.

539.152.2

1923. Nuclear specific heats of copper salts. R. J. MACKENZIE AND A. H. COOKE. Letter in *Nature, Lond.*, **164**, 837 (*Nov.* 12, 1949).

Between 1·0 and 4·2°K the mag. susceptibilities and specific heats C of the double sulphates of Cu with NH_4, K, Rb, Cs and also of the same salts diluted with the corresponding Zn salts were measured by the magnetic relaxation method. Extrapolation to zero Cu concentration of the specific heat constant CT^2/R gives for all salts a value of $1\cdot1\times10^{-4}$ degree^2 per Cu atom. This represents the contribution to the specific heat of the interaction between the electronic and nuclear magnetic moments of the Cu ions, in agreement with Penrose's observations of the hyperfine structure of the magnetic resonance spectrum of highly diluted Cu salts [Abstr. 5571 (1949)]. Taking the above value for the nuclear specific heat constant, the contributions due to dipole interaction and those due to exchange are calculated for the undiluted Cu salts by the Van Vleck method. H. LONDON

539.152.2

1924. Electric quadrupole moments of nuclei. J. J. BENE, P. M. DENIS AND R. C. EXTERMANN. Letter in *Phys. Rev.*, **76**, 1255 (*Oct.* 15, 1949).

A rule given by W. Gordy [Abstr. 418 (1950)] is extended to give estimates of the quadrupole moments of Zn^{67}, Co^{59}, Rb^{85} and Sb^{123}. L. R. SHEPHERD

539.152.2

1925. Atomic beam magnetic resonance experiments with radioactive elements Na^{22}, K^{40}, Cs^{135} and Cs^{137}. L. DAVIS, JR., D. E. NAGLE and J. R. ZACHARIAS. *Phys. Rev.*, **76**, 1068–75 (*Oct.* 15, 1949).

Modifications of the atomic beam magnetic resonance method for the determination of nuclear spins and moments by observation of the hyperfine structure of atomic ground states are described which make it possible to work with very small quantities in samples with low concentrations. These modifications include the analysis of the beam by means of a mass spectrometer while performing the resonance experiment. A new source of beams of atomic alkali metals is described. The resulting nuclear magnetic moments, in nuclear magnetons, are: Na^{22}, $1\cdot746\pm0\cdot003$; K^{40}, $-1\cdot290\pm0\cdot005$; Cs^{135}, $2\cdot724\pm0\cdot010$; Cs^{137}, $2\cdot837\pm0\cdot010$. A.

539.152.2

1926. Transient nutations in nuclear magnetic resonance. H. C. TORREY. *Phys. Rev.*, **76**, 1059–75 (*Oct.* 15, 1949).

Transient nutations of the resultant nuclear magnetic moment vector are set up by applying radio-frequency power in the form of pulses in the neighbourhood of resonance ($\omega=\gamma H_0$). The nutations have an initial amplitude depending on the state of magnetization at the start of a pulse and on the proximity to resonance, and are damped by spin-spin and spin-lattice interaction. The thermal relaxation time can be directly found by observing the dependence of initial amplitude on the time between pulses. The spin-spin time constant T_2 can be found from the rate of decay even in the presence of normally disturbing inhomogeneity in magnetic field. Sensitivity is in many cases comparable to that obtained in the modulation method with narrow band amplifiers. The fast response due to the relatively wide bandwidths used can be applied to a rapid search for unknown resonances. The effects observed are in qualitative accord with predictions based on the Bloch theory. A.

539.152.2

1927. Nuclear magnetic resonance shift in metals. W. D. KNIGHT. Letter in *Phys. Rev.*, **76**, 1259–60 (*Oct.* 15, 1949).

A shift from expected values of the nuclear magnetic resonance frequencies in Li, Na, Al, Cu and Ga, is reported. Measurements were made in magnetic fields ranging from 5 000 to 10 000 oersted, using an automatic search type radio-frequency spectrometer. The shift for a given isotope is $\propto$ the resonance magnetic field (or frequency) and may be due to the paramagnetic effect of the conduction electrons in the vicinities of the metal nuclei. G. F. HODSMAN

539.152.2 : 535.338.332

1928. On the hyperfine structure in copper Tutton salts. L. J. F. BROER. Letter in *Physica*, **15**, 673–4 (*Sept.*, 1949).

Interaction energy between electronic and nuclear magnetic moments is calculated following Polder [Abstr. 3257 (1947)], with orbital and spin moments of electrons non-coupled. Case of Zeeman splitting $\gg$ hyperfine structure is considered only. Ratio of splitting with field $\parallel$ or $\perp$ is 0·45, experimentally 2. Matrix elements are sensitive to the angular part of wavefunctions; Polder uses hydrogen-like ones. Only the lowest $3d^9$ configuration is used, whereas $3d^84s$ gives rise to 1st order mixing of their wavefunctions; the assumption of point dipoles is also inadequate in Polder's theory. J. JACOBS

539.152.2 : 535.338.332

1929. The hyperfine structure and nuclear moments of the stable chlorine isotopes. L. DAVIS, JR., B. T. FELD, C. W. ZABEL AND J. R. ZACHARIAS. *Phys. Rev.*, **76**, 1076–85 (*Oct.* 15, 1949).

The hyperfine structure of the $^2P_{3/2}$ ground states of Cl^{35} and Cl^{37} is investigated by the atomic beam magnetic resonance method. Values of the magnetic dipole interaction constant, a, and the electric quadrupole interaction constant, b, are found to be $a_{35}=205\cdot288\pm0\cdot01$ Mc/s, $b_{35}=55\cdot347\pm0\cdot02$ Mc/s, $a_{37}=170\cdot686\pm0\cdot01$ Mc/s, $b_{37}=43\cdot256\pm0\cdot02$ Mc/s. No octupole interaction is required to account for the experimental results. A simple method is introduced for calculating accurate values of the electric quadrupole moments Q from these data and the corresponding values are $Q_{35}=-(0\cdot0795\pm0\cdot0005)\times10^{-24}$ cm^2 and $Q_{37}=-(0\cdot0621\pm0\cdot0005)\times10^{-24}$ cm^2. This method can be extended to many other cases for which the interaction constants a and b and the nuclear gyromagnetic ratio are known. Experimental details are given for the production and detection of beams of atomic Cl. A.

539.152.2 : 535.338.332

1930. The hyperfine structure of the $^2P_{3/2}$ state of Al^{27}. The nuclear electric quadrupole moment. H. LEW. *Phys. Rev.*, **76**, 1086–92 (*Oct.* 15, 1949).

The hyperfine structure of the $3p^2P_{3/2}$ state of Al^{27} has been measured by the atomic beam magnetic

resonance method. The magnetic dipole and electric quadrupole interaction constants a and b have been found to be $a = 94{\cdot}25 \pm 0{\cdot}04$ Mc/s, $b = 18{\cdot}76 \pm 0{\cdot}25$ Mc/s. From these, the electric quadrupole moment of the nucleus has been calculated to be $Q = (0{\cdot}156 \pm 0{\cdot}003)10^{-24}$ cm². A.

539.152.2 : 535.338.332

1931. Hyperfine structure and nuclear spin of Kr^{83} and Ne^{21} investigated with separated isotopes. J. Koch and E. Rasmussen. Letter in *Phys. Rev.*, **76**, 1417 (*Nov.* 1, 1949).

Highly enriched samples were prepared using a mass spectrograph, and interferograms obtained for these samples by means of a Fabry–Perot etalon. The spin value for Kr^{83} is confirmed as 9/2. Isotope shifts were also measured. In the case of Ne^{21} the magnetic moment is found to be negative and the spin $\neq 3/2$. A. Harvey

539.153

1932. On the zero field fluctuation energy correction for the ground state of the helium atom. M. Günther. *Physica*, **15**, 675–6 (*Sept.*, 1949).

Discusses whether modern refinements in theory will bring the calculated value of the ionization energy of the He atom into agreement with observation. P. M. Davidson

539.153 : 535.338.332

1933. Effects of the proton radius on nuclear motion correction for the hyperfine structure of hydrogen. G. E. Brown and G. B. Arfken. *Phys. Rev.*, **76**, 1305–6 (*Nov.* 1, 1949).

Contributions to the hyperfine structure of the ground state of H resulting from the assumption of a non-vanishing proton radius are evaluated. These effects occur because of the assumed modification of the coulomb potential inside the proton and the consequent change in the wave function the above assumption implies. Since the proton radius and the shape of the potential function in the interior are not known, there occur uncertainties of relative order $\alpha^2 m/M$ in the hyperfine structure arising from nuclear mass motion. A.

539.153 : 535.338.332

1934. The effect of nuclear motion on the hyperfine structure of hydrogen. G. Breit, G. E. Brown and G. B. Arfken. *Phys. Rev.*, **76**, 1299–1304 (*Nov.* 1, 1949).

The problem is considered from the point of view of a Hamiltonian which is relativistic to order v^2/c^2. The discussion results in a clearer separation of the non-relativistic correction factor $1 - 3m/M$ from relativistic effects than in previous treatments. The Hamiltonian is applied through the interior as well as the exterior of the proton. By means of it the potential energy can be rounded off at small distances without contradiction to relativity, within the order v^2/c^2. A transformation involving a new effective charge allows the calculation of part of the effect without approximation and it becomes clear that higher order effects are not separable from the so far arbitrary assumptions concerning the proton's radius. Relativistic corrections to the fine structure are reconsidered by means of this transformation and the effect of the acceleration of the proton on the hyperfine structure is discussed. A.

539.153.4 : 535.338.33

1935. Electron-nuclear potential fields from hyper fine structure. M. F. Crawford and A. L. Schawlow. *Phys. Rev.*, **76**, 1310–17 (*Nov.* 1, 1949).

Theoretical predictions for the effects of nuclea size on hyperfine structure are compared with experi mental data. New data show that isotope shifts c *ns* levels in Tl III are $\propto \psi^2(0)$ as predicted. Th fractional change in nuclear radius for the additio of two neutrons, determined from *s* electron shift in Hg II, Tl III, Pb IV, is the same for the 3 elements Köhler's results for Tl II are consistent with thos for Tl III when allowance is made for the mutua screening of the valence electrons. Corrections fo the approximation of the perturbation method an for screening of inner electrons by the valence electron are considered and found to be appreciable. Even after applying the corrections, the fractional chang in nuclear radius is $<$ expected if the charge i uniformly distributed throughout the nucleus an the volume is $\propto$ the mass. Values of nuclear mag netic moment of Tl deduced from hyperfine structure measurements are compared with those measured by radiofrequency induction and found to be 15% lower This discrepancy is removed by the correction for finite nuclear size assuming either a uniform charge distribution or a concentration of charge toward the surface of the nucleus. Thus both the isotope shift and the magnetic effect indicate that the electron nuclear potential is consistent with a charge distribution of this form and that the non-electrical forces between electrons and nuclei are relatively small. A.

539.154.2

1936. A preliminary note on nuclear periodic scheme in three dimensions. S. Podgor. Letter in *Phys. Rev.*, **76**, 1271 (*Oct.* 15, 1949).

Nuclear species are plotted in the form of a Segré chart which is divided up and arranged in a series of 7 planes. In each plane the chart starts with the isotopes having a closed shell in neutrons or protons and ends with nuclei having the next highest closed shell in either nucleon. Thus Plane I ends with complete 2-shell nuclei while Plane II starts with these and ends with nuclei having closed shells of 8 protons or neutrons, and so on. L. R. Shepherd

539.155.2 : 523.877

Isotopes in stellar atmospheres. *See Abstr.* 1443

539.155.2

1937. A new determination of the relative abundance of rhenium in nature. H. Brown and E. Goldberg. *Phys. Rev.*, **76**, 1260–1 (*Oct.* 15, 1949).

The rhenium content of 5 Fe meteorites was determined by the neutron activation method. A value about 50 times $>$ that previously accepted was found. This removes the discontinuity at mass numbers 185 and 187 in the curve of the relative abundances as a function of the mass numbers of nuclear species. J. Hughes

539.155.2 : 539.17

1938. On the origin of elements. M. G. Mayer and E. Teller. *Phys. Rev.*, **76**, 1226–31 (*Oct.* 15, 1949).

The abundances of elements and of isotopes indicate that heavy and light elements have been produced by different processes. The origin of heavy elements

discussed in detail. It is assumed that the heavy elements were formed by a fission process from a neutron-rich nuclear fluid. Simple assumptions are made about this fission process and isotopic abundances are calculated for $62 \leqslant Z \leqslant 78$. The properties of the neutron-rich liquid and possible details of the fission process are discussed. A.

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16 : 621.385.1.032.216

1939. Use of radioactive isotopes in the study of oxide cathodes. J. BEYDON, L. BEAUDOIN, J. CHALLONSONNET AND J. DEBIESSE. *C.R. Acad. Sci., Paris*, **229**, 353–4 (*Aug.* 1, 1949) *In French.*

The use of Ba^{140}, Sr^{90} and Sr^{89} for estimating the amount of alkaline earth or alkaline earth oxide evaporated from oxide cathodes is described.

A. H. W. BECK (R)

539.16.08

1940. Use of *Bremsstrahlung* in making rapid assays of millicurie amounts of phosphorus-32. T. ALPER AND L. DU PREEZ. Letter in *Nature, Lond.*, **164**, 1001 (*Dec.* 10, 1949).

A high pressure ionization chamber is used to measure the Bremsstrahlung from therapeutic quantities of P^{32}, the Bremsstrahlung being calibrated against a Ra standard. With 10 mc samples, the measurements fall within the ± 10% variation allowable. This method avoids a number of difficulties inherent in the usual methods of standardization.

C. B. ALLSOPP

539.16.08

1941. The experimental determination by ionization methods of the rate of emission of beta- and gamma-ray energy by radioactive substances. The isotopes Na^{24}, P^{32}, Co^{60} and I^{131}. L. H. GRAY. *Brit. J. Radiol.*, **22**, 677–97 (*Dec.*, 1949).

The known relation between the ionization in cavity type ionization chambers, and the γ-ray energy absorbed per unit mass of the wall material has been employed for the absolute determination of the rate of emission of γ-ray energy by samples of the isotopes Na^{24}, Co^{60} and I^{131}. When the rate of emission of quanta by the sample has been determined by counting procedures, the measured rate of emission of γ-ray energy agrees well with expectation based on the accepted decay schemes of Na^{24} and Co^{60}, and the Metzger Deutsch scheme for I^{131}. In principle an analogous method may be used to measure the absolute rate of emission of β-ray energy by a sample of isotope uniformly incorporated in the walls of a cavity type ionization chamber. Measurements of the rate of emission of β-ray energy by Na^{24}, P^{32}, Co^{60} and I^{131}, have been made by means of ionization chambers lined with gelatine containing these isotopes. By comparing the results with the rate of emission of γ-ray energy from the same sample of isotope, the following values have been obtained for the ratio of the mean β-ray energy to the γ-ray energy emitted per disintegration: $Na^{24} = 0{\cdot}139 \pm 0{\cdot}007$, $Co^{60} = 0{\cdot}043 \pm 0{\cdot}002$, $I^{131} = 0{\cdot}505 \pm 0{\cdot}025$. These figures are in satisfactory agreement with the accepted decay schemes for Na^{24} and Co^{60}, and the Metzger Deutsche scheme for I^{131}. The principles of the method and the factors which limit accuracy are discussed in some detail. In the case of the β-ray measurements, errors arising from the finite size of the chamber and the use of gelatine linings of thickness less than the maximum β-ray range of the isotope under investigation are evaluated experimentally. It is concluded that when all sources of error are taken into account absolute γ-ray energy measurements may be considered reliable to about 4%, β-ray measurements to about 6%, and the ratio of β- to γ-ray energy to about 5% for the isotopes studied. A.

539.16.08

1942. Chemical measurement of ionizing radiations. M. J. DAY AND G. STEIN. Letter in *Nature, Lond.*, **164**, 671–2 (*Oct.* 15, 1949).

Dilute solutions of benzene and sodium benzoate yield hydroxylation products which can be measured colorimetrically, and the yield is shown to be ∝ dose and independent of λ of the ionizing radiation. Absolute yields are of the order of 6 μ-gm per cm^3 per *r*. The measuring technique is of value for very high dose rates and for high energy quanta, as well as for β-radiations in solutions. F. T. FARMER

539.16.08

1943. Self-absorption of S^{35} radiation in barium sulfate. F. C. LARSON, A. R. MAASS, C. V. ROBINSON AND E. S. GORDON. *Analyt. Chem.*, **21**, 1206–7 (*Oct.* 15, 1949).

A technique has been developed for the collection of radioactive precipitates utilizing centrifuge tubes with removable flat bottoms. A study of the self-absorption of S^{35} activity in $BaSO_4$ has been reported. A value of 0·216 cm^2/mg was found for the self-absorption coeff. of S^{35} in $BaSO_4$ on a Lusteroid backing. A.

539.16.08 : 537.542

1944. A wide range radiation instrument. L. REIFFEL AND G. BURGWALD. *Rev. Sci. Instrum.*, **20**, 711–15 (*Oct.*, 1949).

A radiation monitoring instrument based on the scintillation counter is described which measures γ- (or β-) radioactivity levels from 1 milliroentgen/hr to 100 roentgens/hr without changing scale. The instrument may thus be entirely unattended even in the vicinity of widely varying sources. Its performance and limitations are discussed, together with means for increasing its ultimate sensitivity. A.

539.162 : 537.133

1945. On the negative proton. K.-H. SUN. Letter in *Phys. Rev.*, **76**, 1266 (*Oct.* 15, 1949).

Negative proton emission is always possible, at least from energy considerations alone, in any process involving delayed neutron emission. It is suggested that the emission could be detected with a cloud chamber in a magnetic field where N^{17} is produced, or alternatively, by observing the annihilation radiation produced. G. J. KYNCH

539.162 : 539.164.93

1946. The possible existence of the $4n + 1$ radioactive series in chloritized Ytterby mica. J. H. J. POOLE, C. F. G. DELANEY AND R. C. MCCORMICK. Letter in *Phys. Rev.*, **76**, 1253–4 (*Oct.* 15, 1949).

539.163

1947. New radioactive isotopes of dysprosium. B. H. KETELLE. Letter in *Phys. Rev.*, **76**, 1256 (*Oct.* 15, 1949).

Two new radioactive isotopes of Dy were established by irradiating highly purified Dy oxide with slow neutrons and separating the resulting activities by ion exchange methods. The reactions found were: $Dy^{164}(n,\gamma)Dy^{165}$, then either ($\beta$, 138 min)$Ho^{165}(n,\gamma)$; or $(n,\gamma)Dy^{166}(\beta, 0{\cdot}4$ MeV, 80 hr); to $Ho^{166}(\beta, 27{\cdot}3$ hr) Er^{166}. The cross-section of Dy^{165} for neutron activation was $\sim 5\,000$ barns. A residual activity of $\frac{1}{2}$-life (140 ± 10) d, decaying by orbital electron capture was assigned to Dy^{157} or Dy^{159}. A. O. STANESBY

539.163

1948. Calculation of the ratio of probabilities of nuclear capture of L_1 and K electrons for A^{37}. P. BENOIST AND M. JEAN. *C.R. Acad. Sci., Paris*, **228**, 1848–50 (*June* 13, 1949) *In French.*

The calculation was carried out using Hartree functions instead of the Schrödinger functions used by Marshak [Abstr. 1867 (1942)]; the calculated ratio, ρ = probability of L_1 capt./probability of K capt. = 0·081, agrees much better with the experimental value of Pontecorvo *et al.* A. O. STANESBY

539.163

1949. The decay of ^{170}Tm and ^{186}Re. P. J. GRANT AND R. RICHMOND. *Proc. Phys. Soc., Lond. A*, **62**, 573–80 (*Sept.*, 1949).

The radiations from the active isotopes Tm^{170} and Re^{186} have been investigated. Tm^{170} is found to have a β-ray end-point of $1{\cdot}00 \pm 0{\cdot}005$ MeV with possible lower-energy groups at $0{\cdot}90 \pm 0{\cdot}015$, $0{\cdot}79 \pm 0{\cdot}025$, $0{\cdot}45 \pm 0{\cdot}05$ MeV. γ-rays with energies $82{\cdot}6 \pm 0{\cdot}5$, 205 ± 10, 430 ± 20 keV were observed. The 430 keV radiation is thought to be complex. Re^{186} is found to have a β-ray end-point of $1{\cdot}090 \pm 0{\cdot}005$ MeV with other groups at $0{\cdot}95 \pm 0{\cdot}015$ and $0{\cdot}64 \pm 0{\cdot}03$ MeV. 3 γ-rays were observed, having energies 700 ± 50, 275 ± 8 and 133 ± 1 keV. The last is assumed to be a mean energy-value of the 3 low-energy γ-rays found by Cork, Shreffler and Fowler [Abstr. 2691 (1949)]. Decay schemes are suggested for both isotopes. A.

539.163.1

1950. Half-lives of ^{141}Ce and ^{169}Yb. D. WALKER. *Proc. Phys. Soc., Lond. A*, **62**, 799–801 (*Dec.*, 1949).

The $\frac{1}{2}$-lives have been redetermined as $33{\cdot}11 \pm 0{\cdot}23$ d and $31{\cdot}83 \pm 0{\cdot}21$ d respectively. The errors appear to be < in previous determinations. A.

539.163.2

1951. Radioactivity of chlorine^{36}. C. S. WU, C. H. TOWNES AND L. FELDMAN. Letter in *Phys. Rev.*, **76**, 692–3 (*Sept.* 1, 1949).

The isotopic concentration of Cl^{36}, contained in a sample of HCl, was determined from the relative intensities of the $J = 1 \rightarrow 2$ microwave absorption lines of $Cl^{36}C^{12}N^{14}$ and $Cl^{35}C^{13}N^{14}$ in ClCN prepared from the sample. The absolute β-disintegration rate of the Cl was determined using a G.M. counter in a standardized arrangement with a NaCl source deposited on a Ag disc. The $\frac{1}{2}$-life of Cl^{36} was deduced from the measurements, a value $0{\cdot}44 \pm 0{\cdot}05 \times 10^6$ yr being obtained. No γ-radiati or positrons (> 20 keV) could be detected in t radiation from the source, an upper limit of 10^{-4} r electron being set for the positron emission.

L. R. SHEPHEE

539.1

1952. Alpha-decay in isotopes of atomic numb less than 83. S. G. THOMPSON, A. GHIORSO, J. RASMUSSEN AND G. T. SEABORG. Letter in *Phys. Re* **76**, 1406 (*Nov.* 1, 1949).

α-activities were produced by high energy bombar ment of Au, Pt, Gd and Dy. With the heavy targe $\frac{1}{2}$-lives of 0·7 and 4·3 min, energies 5·7 and 5·2 Me resulted, α/electron capture $\sim 10^{-4}$, also β^+ activi with the longer period. With the rare earths, $\frac{1}{2}$-liv ~ 7 and 20 min and ~ 4 hr, energies 4·2, 4·1 an 4·0 MeV, less β^+-activity, and α/electron captu $> 10^{-2}$. It is suggested that the rare earth perio are associated with the 82 neutron shell. B. RO

539.1

1953. Fine structure of the alpha particle spectru of thorium X. S. ROSENBLUM, M. VALADARE M. PEREY AND J. VIAL. *C.R. Acad. Sci., Paris*, **22** 1009–11 (*Nov.* 15, 1949) *In French.*

[Continues Abstr. 7240 (1949)]. The spectru consists of 3 lines of α-particle energies 5·681 (α_0 5·448 (α_1) and 5·194 MeV (α_2). The relative inte sities (1, 0·05 and 0·004 resp.) are in agreement wit Gamow's theory for the transition ThX $\rightarrow$ Tn.

A. O. STANESB

539.16

1954. The complexity of the α-radiation of protact nium. S. ROSENBLUM, E. COTTON AND G. BOUISSIÈRE *C.R. Acad. Sci., Paris*, **229**, 825–7 (*Oct.* 24, 1949) *In French.*

[Continues Abstr. 2183 (1948)]. With a thinne source of Pa spontaneously deposited on Zn, an using exposures of 15 days, at least 6 lines wer obtained; the α-particle energies were 5·042 (α_0 5·002 (α_1), 4·938 (α_2), 4·838 (α_3), 4·720 (α_4) an 4·660 MeV (α_5); the relative intensities were 0·11 0·47, 0·25, 0·03, 0·11, $\sim 0{\cdot}02$ respectively.

A. O. STANESB

539.16

1955. A determination of the mean range of th alpha particles of ^{235}U. G. J. VAN DER MAAS AN J. L. YNTEMA. *Physica*, **15**, 807–24 (*Sept.*, 1949).

A method of determining the mean range usin a deep ionization chamber connected to a linea amplifier is described. The measurements wer made on a non-enriched U sample. A special metho was developed for the determination of the relation ship between residual range in the chamber and the deflection of the oscillograph. The theory of thi method is given. Taking the mean range of U^{238} t be 27·02 mm (760 mm Hg 15°c), the mean range o U^{235} was found to be $29{\cdot}00 \pm 0{\cdot}20$ mm. The ratio of the number of α-particles of U^{235} and U^{238} is in good agreement with the results of Nier. The appendix gives a numerical method for determining the convolution of two functions, where one is a Gaussian function. A.

539.164.93

1956. The effect of electric fields on the decomposition of ethane by alpha-rays. N. T. Williams and H. Essex. *J. Chem. Phys.*, **17**, 995–7 (*Oct.*, 1949).

In the decomposition of ethane by α-rays the reaction is largely initiated by splitting of molecules on ionization and by splitting of molecules without ionization on electron collision. The application of even a weak electric field results in an increased ion yield in ethane, a phenomenon which has not been observed in other gases studied by this method, and this is attributed to inhibition by the field of a reaction involving ions which decreases the amount of non-condensed gas produced. The application of higher fields results in another increase in the ion yield due to the collisions of electrons accelerated by the field which cause splitting with or without attachment. At the lower pressure, a final constancy of the ion yield at high fields can be attributed to the final attachment of all of the free electrons to molecular fragments. The reaction at the higher pressure was not followed to sufficiently high values of X/p to exhibit the same high field effect. A.

539.165

1957. Betatron produced sources of high specific activity: copper 62. R. A. Becker, F. S. Kirn and W. L. Buck. Letter in *Phys. Rev.*, **76**, 1406–7 (*Nov.* 1, 1949).

The spectrum was measured and found to have an end point at $2{\cdot}83 \pm 0{\cdot}05$ MeV, in disagreement with earlier work [Abstr. 4531 (1939)]. The sources, 5 mc, 11 mg/cm², were produced on a probe inside a 22 MeV betatron. B. ROSE

539.165

1958. The beta-spectrum of O^{15}. V. Perez-Mendez and H. Brown. Letter in *Phys. Rev.*, **76**, 689 (*Sept.* 1, 1949).

N circulated through a hollow probe was bombarded, through a thin window, by 8 MeV deuterons, to give O^{15} by the $N^{14}(d, n)$ reaction. The gas was passed into the source chamber of a semi-circular focusing spectrometer in which measurements were carried out on the spectrum of the β-particles emerging through a thin cellophane window, the source activity being continuously monitored by a counter. The Fermi plot was straight down to 300 keV, from the end point at $1{\cdot}683 \pm 0{\cdot}005$ MeV. The deviation below 300 keV was attributed to source and source-chamber-window thicknesses. The $\frac{1}{2}$-life of O^{15} was found to be $118{\cdot}0 \pm 0{\cdot}7$ sec, indicating that the β-decay is allowed.

L. R. SHEPHERD

539.165

1959. Electrons emitted from protactinium. J. Teillac. *C.R. Acad. Sci., Paris*, **229**, 650–1 (*Oct.* 3, 1949) *In French.*

A Pa source $\sim 0{\cdot}02$ μcuries was studied in a Wilson chamber, 912 α-particles and 228 electron tracks being observed. Electron groups were found, of energies 24, 36 and 46 keV (deduced from ranges) and intensities 12, 7·5 and 3 electrons per 100 α-particles respectively. These are attributed to L conversion of γ-rays of energies 44, 56 and 66 keV. Higher energy electrons ~ 70 keV emitted in 2% of the disintegrations are interpreted as L conversion electrons of a γ-ray of energy, given previously by Meitner as 95 keV. These γ-ray energies can be matched approximately to the known fine structure of the α-spectrum. L. R. SHEPHERD

539.165

1960. The beta-spectrum of Be^{10}. H. W. Fulbright and J. C. D. Milton. Letter in *Phys. Rev.*, **76**, 1271–2 (*Oct.* 15, 1949).

Be^{10} sources in the form of BeO deposits 0.5–$3{\cdot}5$ mg/cm² thick, were mounted on 0.2 mg/cm² Al foil, between the parallel wire collectors of a 4π solid angle counter. This was enclosed in a pressure vessel filled to 700 p.s.i. with continuously purified A and operated in the proportional region with twofold multiplication. An identical counter containing a Cs^{137} source was mounted in the same vessel, the Ba^{137} conversion line being used for pulse height calibration. The Be^{10} and Cs^{137} β-spectra were obtained and allowed Kurie plots revealed departure from the allowed shape of spectrum in both cases. A forbidden plot of the Be^{10} spectrum using Marshak's D_2 correction gave a straight line with the kinetic energy end-point $0{\cdot}553 \pm 0{\cdot}015$ MeV, thus confirming the validity of Marshak's predictions.

L. R. SHEPHERD

539.165

1961. Positive-particles associated with beta-ray emitters. K. L. Erdman, G. T. Kokotailo and D. B. Scott. Letter in *Phys. Rev.*, **76**, 1262 (*Oct.* 15, 1949).

Collimated and uncollimated β-rays from S^{35}, UX, Ra($D + E$) and P^{32} were studied in a cloud chamber, with 250 gauss magnetic field and 1 atmos. pressure air filling. Tracks, apparently due to positive particles, were observed, but it is shown that these were caused by spurious effects such as reflection of electrons back to the source and "positive" track curvature resulting from scattering of low energy electrons. Apparent pairs ejected from Pb foil by the β-particles were also shown to be spurious.

L. R. SHEPHERD

539.165

1962. Origin of low-energy electron lines in the β-spectrum of ^{198}Au. B. V. Thosar. Letter in *Proc. Phys. Soc. A*, **62**, 739 (*Nov.*, 1949).

K and L conversion lines due to 0·125 MeV and 0·072 MeV transitions, respectively, have been observed in pile irradiated Au, examined in a 254° radial electrostatic field spectrometer. It is suggested that these radiations are not part of the decay of Au^{198}, which is produced by slow and resonance neutrons, but are due to transitions in Au^{197}, following β^- decay of Pt^{197}, formed by fast neutrons in the reaction $Au^{197}(n, p)Pt^{197}$. This is confirmed by the fact that these radiations are increased relative to the known Au^{198} radiations, when self-shielded Au foils are irradiated by pile neutrons. L. R. SHEPHERD

539.165

1963. Cloud-chamber study of high energy positrons from Na^{22}. K. H. Morganstern and K. P. W. Wolf. Letter in *Phys. Rev.*, **76**, 1261–2 (*Oct.* 15, 1949).

3·0 yr Na^{22} decays by emission of 0·56 MeV

(end-point) positrons to a 1·3 MeV level in Ne^{22}. A search was made for positron transitions to the ground state which, according to Feenberg, should occur in ~1 transition out of every 10 000. A weak Na^{22} source on thin Al backing was suspended in a H and C_2H_5OH-filled cloud chamber, which used a pulsed magnetic field. 69 tracks of high energy positrons were observed in 6 000 pictures and these appeared to belong to a spectrum with the correct energy end-point for the ground-state transition. It is estimated that > 1 in 26 000 transitions occurs to the ground-state of Ne^{22}. L. R. SHEPHERD

539.165

1964. On the double beta-process. M. G. INGHRAM AND J. H. REYNOLDS. Letter in *Phys. Rev.*, **76**, 1265–6 (*Oct.* 15, 1949).

A sample of Xe was obtained by heating, under vacuum, a quantity of Bi_2Te_3 from andalusite and sericite rock of Swedish origin. The isotopic constitution of this gas was measured in a mass spectrometer and compared with Nier's values for normal Xe. Xe^{130} appeared to be in slight excess in the telluride Xe (relative to Xe^{134}) and it was possible to place an upper limit on the excess of Xe^{128} in the mineral sample, though the measurement was not accurate enough to obtain a precise value on this excess, if any. These results were used to establish lower limits on the ½-lives of the double β-transitions $Te^{128} \rightarrow Xe^{128}$ and $Te^{130} \rightarrow Xe^{130}$, the respective values being $1{\cdot}3 \times 10^{19}$ yr and $8{\cdot}0 \times 10^{19}$ yr (assuming a mineral age of $1{\cdot}5 \times 10^9$ yr and that no Xe escapes from the telluride during this period). The estimated ½-lives appear to correspond more closely to the Dirac theory than to the Majorana theory of the neutrino. L. R. SHEPHERD

539.165

1965. The disintegrations of Sn^{121} and Sn^{123}. R. B. DUFFIELD AND L. M. LANGER. Letter in *Phys. Rev.*, **76**, 1272–3 (*Oct.* 15, 1949).

The momentum distribution of the electrons emitted by Sn^{123} (39·5 min period) is given. Added to the β-spectrum is γ-radiation of energy 0·153 ± 0·005 MeV. A Fermi plot gives an extrapolated end-point of 1·26 ± 0·01 MeV. A similar distribution for Sn^{121} (28 hr period) shows no γ-radiation and the extrapolated end-point is 0·383 ± 0·005 MeV.

H. J. H. STARKS

539.165

1966. On the β-spectra of Cu^{64}. S. GOTÔ, E. KANAI AND M. KOBAYASI. Letter in *Progr. Theor. Phys.*, **3**, 449–50 (*Oct.–Dec.*, 1948).

The emission of 3 neutrinos in β-decay would give a spectrum in better agreement with experiment than the usual one, except at low energies. G. J. KYNCH

539.165

1967. Some remarks on the theory of β-disintegration. S. TAKAGI. Letter in *Progr. Theor. Phys.*, **3**, 445–6 (*Oct.–Dec.*, 1948).

β-decay with the emission of 3 neutrinos [see preceding Abstr.] would occur if a nucleon emitted a meson + neutrino, the former decaying with the emission of 2 more neutrinos. The probability of such a process is, however, far too small with the present range of meson masses. G. J. KYNCH

539.165

1968. The disintegration of Sb^{125} and Te^{125*}. K. SIEGBAHN AND W. FORSLING. *Ark. Fys.*, **1**, *Paper* 24, 505–13 (1949).

A chemical procedure is described to separate Sb^{125} and Te^{125*} with high spec. activities from a large amount of neutron irradiated Sn. The γ-radiation has been analysed in a magnetic spectrograph. The following γ-lines exist: 35 keV, 110 keV, 175 keV, 425 keV, 465 keV, 601 keV and 637 keV. The β-spectrum contains internal conversion lines, corresponding to those found in the γ-spectrum, together with 1 additional electron line, interpreted as an Auger line. The continuous spectrum has been resolved into 3 different β-components, namely $E_{\beta_1} = 128$ keV, $E_{\beta_2} = 299$ keV, $E_{\beta_3} = 616$ keV with relative intensities 33%, 49% and 18%. The internal conversion spectrum emitted from Te^{125*} has been investigated. The $K : (L + M)$ ratio of the 110 keV transition is 1·10. Besides these lines two other lines have been found. One of them is a conversion line from the L shell, the corresponding γ-energy being 35 keV, and one is an Auger electron line, showing a transition K-L-L^1. A term scheme is proposed, which accounts for the results obtained. It seems probable that the 3 β-components are (with increasing energy) 1st forbidden, 2nd forbidden and 3rd forbidden. A.

539.165

1969. Disintegration of I^{124} and I^{126}. A. C. G. MITCHELL, J. Y. MEI, F. C. MAIENSCHEIN AND C. L. PEACOCK. *Phys. Rev.*, **76**, 1450–3 (*Nov.* 15, 1949).

The nuclear radiations from I^{124} (4 d) and I^{126} (13 d) have been measured. I^{124} decays to Te^{124} with the emission of 3 positron groups with end points at 2·20 ± 0·01, 1·50 ± 0·01 and 0·67 ± 0·05 MeV, possibly accompanied by some K-electron capture. γ-rays of energy 0·603 ± 0·002, 0·73 ± 0·01, 1·72 ± 0·02 and 1·95 ± 0·05 MeV are given off in the disintegration. I^{126} decays to Xe^{126} with the emission of 2 β-ray groups of energies 1·268 ± 0·010 and 0·85 ± 0·01 MeV, together with a γ-ray of energy 0·395 ± 0·005 MeV. An active state of I, of 13·0 ± 0·5 hr ½-life, which decays by K-capture and the emission of an internally converted γ-ray of energy 0·159 MeV, has been found. This activity is assigned to I^{123}. A.

539.165

1970. Radioactive In^{107}, In^{108}, In^{109}, and Sn^{108}. E. C. MALLARY AND M. L. POOL. *Phys. Rev.*, **76**, 1454–7 (*Nov.* 15, 1949).

A new In isotope which decayed with a 33 ± 2 min ½-life has been produced by deuteron and proton bombardments of Cd 106. Evidence for the assignment of the activity to In 107 is given. Characteristic radiations are positrons of 2 MeV energy and γ-rays. An In isotope which decayed with a 4·30 ± 0·15 hr ½-life has been produced by a deuteron and proton bombardment of Cd 108 and by an α-bombardment of Cd 106. The assignment is made to In 109. Decay is by emission of 0·75 ± 0·05 MeV positrons, by K-electron capture, and by emission of γ-rays. Two genetically related isotopes in Sn and In have been assigned to mass number 108. The Sn isotope,

which is produced by bombarding Cd 106 with α-particles, decays with a $\frac{1}{2}$-life of 4·5 hr by *K*-electron capture. The In isotope, which is produced by the decay of the Sn isotope and by bombarding Cd 108 with deuterons, decays with a $\frac{1}{2}$-life of about 5 min by emitting positrons of 2 MeV energy and γ-rays. A.

539.166

1971. Gamma-radiation from Br^{82}. K. Siegbahn, A. Hedgran and M. Deutsch. Letter in *Phys. Rev.*, **76**, 1263 (*Oct.* 15, 1949).

A large double focusing spectrometer of $\sim 1\%$ resolution was used to study the conversion electron spectrum of a Br^{82} source and also the spectrum of photoelectrons ejected from a Pb radiator by Br^{82} γ-radiation. 7 γ-rays were identified, with energies ranging from 0·547 MeV to 1·312 MeV. The relative intensities of the *K*-conversion lines are given. L. R. SHEPHERD

539.166

1972. Absorption of gamma-rays in aluminum. W. C. Parkinson. *Phys. Rev.*, **76**, 1348–52 (*Nov.* 1, 1949).

The scattering cross-section for γ-rays in Al was measured by 2 independent methods at the 3 energies 1·11, 1·71 and 2·76 MeV. The results 0·156, 0·125 and 0·0996 cm^{-1}, respectively, for the 3 energies are in agreement with the predictions of theory within the experimental error of $\pm 1\%$. The essential features of the measurements are: (1) choice of γ-ray energies and absorbing material such that Compton scattering is the only important process; (2) use of geometry which effectively eliminates single and multiple scattering and permits an accurate determination of the background; (3) elimination of errors due to the other γ-ray energies emitted by the source; (4) determination of corrections for absorber impurities, counter deadtime and random fluctuations in the counters and counter circuits. The 2 methods of measurement differ primarily in the way in which the errors due to the other γ-rays emitted by the source are removed. A.

539.166.2

1973. Directional correlation between successive internal-conversion electrons. J. W. Gardner. *Proc. Phys. Soc., Lond. A*, **62**, 763–79 (*Dec.*, 1949).

For the internal conversion of successive electric multipole quanta by *s*-electrons, unaccompanied by spin reversal, the directional correlation between the ejected electrons can be derived by symmetry arguments alone. A general formula is established and special cases likely to be of practical interest are tabulated. Comparison is made with Hamilton's results for γ–γ correlation. A.

539.166.74

1974. Experimental study of the Compton effect at 1·2 MeV. R. Hofstadter and J. A. McIntyre. Letter in *Phys. Rev.*, **76**, 1269–70 (*Oct.* 15, 1949).

Scintillation counting techniques have been adapted to measure the angular distribution of Compton scattered radiation, with a Co^{60} γ-ray source. Stilbene crystals were used both as scatterer and detector. The Co^{60} γ-rays were collimated into a narrow beam and directed on to the scattering crystal. Each scattered γ-photon was observed through the scintillation produced in the scatterer by the recoiling electron and the coincidence rate between scintillations caused by the recoil electrons in the scatterer and those produced by the absorbed photons in the detector, was studied as a function of the angular separation of the incident and scattered photon directions. A thin Al foil between scatterer and detector prevented the latter from recording recoil electrons from the former. The observed coincidence rates corrected for detector efficiency, absorption of incident and scattered photons in the scattering crystal and various spurious scattering and absorption effects gave the required angular distribution of the Compton scattered photons. The results are in good agreement with the theoretical Klein–Nishina distribution. L. R. SHEPHERD

539.166.831

1975. On the photoelectron spectrum of Ta^{182}. C. H. Goddard and C. S. Cook. Letter in *Phys. Rev.*, **76**, 1419–20 (*Nov.* 1, 1949).

Photoelectrons from U and Pb radiators, ejected by Ta^{182} γ-rays in the energy region below 330 keV, were examined in a 14 cm radius of curvature uniform field spectrometer. 8 γ-radiations with energies 71, 84, 103, 151, 180, 209, 220 and 261 keV were identified from photoelectrons produced in both radiators. γ-radiations of 1·12, 1·19 and 1·23 MeV were also identified from U photoelectrons. L. R. SHEPHERD

539.166.84

1976. Angular distribution of annihilation radiation. S. de Benedetti, C. E. Cowan and W. R. Konneker, Letter in *Phys. Rev.*, **76**, 440 (*Aug.* 1, 1949).

The coincidence rate between 2 crystal counters equidistant from a source of annihilation radiation (Cu^{64} surrounded by Au) was measured as a function of angle over a range $\sim \pm 1°$ about the symmetrical position in which the line joining the centres of the crystals intersected the source. The mean centre of mass momentum of the annihilating pairs was found to be $\sim 0{\cdot}9 \,.\, 10^{-2}\, mc$, agreeing with the findings of Dumond *et al.* [Abstr. 3421 (1949)]. A. P. FRENCH

539.166.9

1977. Relative cross sections for pair production at 17·6 Mev. R. L. Walker. *Phys. Rev.*, **76**, 1440–4 (*Nov.* 15, 1949).

These have been measured for Li, C, Al, Cu, Sn and Pb. A γ-ray pair spectrometer was used to count the number of pairs emitted from thin radiators of these materials when irradiated by 17·6 MeV γ-rays produced in the $Li^7(p, \gamma)Be^8$ reaction. For each material, the number of pairs counted per atom of radiator has been extrapolated to a radiator of zero thickness, in order to obtain the relative pair cross-section. From these measurements some information can be obtained about the probability of pair production in the field of the atomic electrons, and about the errors in the theoretical pair cross-sections of heavy elements, which presumably arise from the use of the Born approximation. It is found that the ratio of the pair cross-section of an electron to that of a nucleus of unit charge is $0{\cdot}8 \pm 0{\cdot}3$. The data indicate that the pair cross-sections of heavier elements are $<$ predicted by the Born approximation,

in qualitative agreement with measurements of the total absorption cross-sections. A.

539.166.9

1978. On the production of electron pairs in the field of an electron. J. A. PHILLIPS AND P. G. KRUGER. *Phys. Rev.*, **76**, 1471–8 (*Nov.* 15, 1949).

The ratio, $R = \sigma\text{-pairs}/\sigma\text{-triplets} = C(Z^2)_{ef}/Z_{ef}$ for 3 gases, CH_4, air and A, has been studied and C found to be 3·63, 3·97 and 4·11, respectively. The average value of C from these data is $3{\cdot}92 \pm 0{\cdot}26$. The γ-rays from $F^{19}(p, \alpha)\gamma O^{16}$ were used in this experiment. The measured energies of the γ-rays as deduced from pairs formed in CH_4 are $6{\cdot}13 \pm 0{\cdot}06$ and $7{\cdot}12 \pm 0{\cdot}07$ MeV. Data on the energy distribution of the low energy negative electron of the triplet are included. A.

NUCLEAR REACTIONS 539.17

539.17 : 523.11

The genesis of the chemical elements. *See Abstr.* 1389

539.17 : 539.155.2

On the origin of elements. *See Abstr.* 1938

539.172.1

1979. The transformation of the nitrogen isotope of mass 15 into carbon and helium by bombardment with protons. W. COCHRANE AND A. G. HESTER. *Proc. Roy. Soc. A*, 458–68 (*Dec.* 7, 1949).

Measurements of the cross-section of the reaction $N^{15}(p, \alpha)C^{12}$ have been made for protons with different values of the energy in the interval between 200 and 450 keV. There are indications of a broad max. in the curve showing the variation of cross-section with energy, in the neighbourhood of 400 keV, with a width of 150 keV. The partial proton width of the max. is 250 eV. Extrapolation of the one-level dispersion formula, together with the theory of thermonuclear reactions, gives a life-time of 3×10^4 yr for N^{15} in the sun. A photographic method of determining the angular distribution of the emitted α-particles is described. The angular distribution near 400 keV is found to be approximately isotropic, the deviations from isotropy being, at most, 10%. A.

539.172.1

1980. Cross section as a function of angle for the $D(d, n)He^3$ reaction for 10-Mev bombarding deuterons. K. W. ERICKSON, J. L. FOWLER AND E. J. STOVALL, JR. *Phys. Rev.*, **76**, 1141–5 (*Oct.* 15, 1949).

By counting He^3 particles with a proportional counter, the differential cross-sections for the reaction have been measured at laboratory angles from 16·5 to 38·2 degrees (39·3 to 95·0 degrees in centre of mass system), for an incident deuteron energy of 10·3 MeV. In the centre of mass system, the differential cross-section is $4{\cdot}5 \times 10^{-27}$ cm² at 90 degrees, decreasing to a min. of $2{\cdot}2 \times 10^{-27}$ cm² at about 45 degrees, and rising steeply at lower angles. By determining the neutron yield with $Cu^{63}(n, 2n)Cu^{62}$ detectors, the differential cross-section at zero degrees is found to be about 5 times that at 90 degrees (centre of mass). A.

539.172

1981. Deuteron bombardment of boron isotopes. E. L. HUDSPETH AND C. P. SWANN. *Phys. Rev.*, 7 1150–6 (*Oct.* 15, 1949).

The excitation curve for $B^{11}(d, p)$ has bee obtained by observing the intensity of the β-ra from B^{12} as a function of bombarding voltage fro about 0·3 to 1·85 MeV. No resonance structu was observed in this region of bombardment. Th yield at 1·47 MeV $\simeq 10^7$ β-rays/microcoulomb deuterons. The short-range protons which a formed in the above reaction were also observed photographic plates, and range measurements showe that the Q-value of the reaction is 0·15 MeV. It believed that this value does not represent the forma tion of B^{12} in its ground state, however, but in a excited state at about 1·1 MeV. A group believed t be protons of higher energy (corresponding t $Q = 1{\cdot}25$ MeV) but of much lower intensity wa subsequently observed. It was shown, by bombarc ment of enriched B^{10} and of normal B, that a γ-ra of approximately 1·1 MeV energy is associated wit the disintegration of B^{11} by deuterons. It is therefor almost certain that this γ-ray arises from the deca of B^{12} to its ground state. Intensity measurement also indicate that this is the case. A

539.172.1 : 539.164 : 539.155.

1982. New low mass isotopes of emanation (elemen 86). A. GHIORSO, W. W. MEINKE AND G. T. SEABORG Letter in *Phys. Rev.*, **76**, 1414 (*Nov.* 1, 1949).

Two gaseous α-emitters of $\frac{1}{2}$-lives 23 min an 2·1 hr were identified amongst the spallation product of Th^{232} bombarded by 350 MeV protons. The activities were assigned to isotopes of emanation (Em) of mass-number (A) < 212. The α-particle energies could not be measured. A. O. STANESBY

539.172.11

1983. Carrier free radioisotopes from cyclotron targets. I. Preparation and isolation of Sn^{113} and In^{114} from cadmium. R. D. MAXWELL, H. R. HAYMOND, D. R. BOMBERGER, W. M. GARRISON AND J. G. HAMILTON. Letter in *J. Chem. Phys.*, **17**, 1005 (*Oct.*, 1949).

The isotopes were produced by α-bombardment at 38 MeV. The chemical treatment of the targets is described in detail. B. ROSE

539.172.13

1984. Influence of the nature of the target on the chemical states of radionitrogen produced by the reaction $C_6^{12}(d, n)N_7^{13}$. P. SUE. *C.R. Acad. Sci., Paris*, **229**, 878–80 (*Nov.* 2, 1949) *In French.*

After bombardment of targets of degassed graphite and of Li_2CO_3, the N^{13} activity was found to be mainly in ammonia and in nitrate form respectively.

B. ROSE

539.172.13

1985. Investigation of protons formed upon bombardment of magnesium by deuterons. YU. A. NEMILOV AND L. I. GEDEONOV. *Dokl. Akad. Nauk, SSSR*, **63** (*No.* 2) 115–18 (1948) *In Russian.*

The absorption of the protons in Al was observed. Nuclear energy levels in Mg are deduced from discontinuities in the proton absorption curve. The allocation of these levels to the existing Mg isotopes is discussed. E. P. GEORGE

539.172.13

1986. Yield and angular distribution of the D–D neutrons. G. T. HUNTER AND H. T. RICHARDS. *Phys. Rev.*, **76**, 1445–9 (*Nov.* 15, 1949).

The differential and total cross-sections for neutron emission from the d–d reaction have been measured for deuteron energies between 0·5 and 3·7 MeV. A "thin" D gas target and an energy insensitive neutron detector were used in the measurements. The yield in the centre of mass co-ordinates was of the form $N(\theta) = K(1 + A\cos^2\theta + B\cos^4\theta + C\cos^6\theta)$; the total cross-section was essentially constant (0·1 barn) for deuteron energies > 1 MeV. The coeff. A was found to be negative above 1·4 MeV and appreciable $\cos^4\theta$ was needed at all energies. Above 2·5 MeV, a $\cos^6\theta$ term was also appreciable. The angular distribution results can be understood qualitatively in terms of penetration of coulomb and centrifugal barriers plus spin-orbit coupling. A.

539.172.13

1987. Range distribution of the charged particles from the D–D reactions for 10-Mev deuterons: differential elastic scattering cross section at 40 degrees, 60 degrees, and 80 degrees in the center-of-mass system. L. ROSEN, F. K. TALLMADGE AND J. H. WILLIAMS. *Phys. Rev.*, **76**, 1283–7 (*Nov.* 1, 1949).

Microphotographic techniques have been used to obtain the range distribution of the charged particles resulting from the D–D reactions at centre of mass angles of 40 degrees, 60 degrees and 80 degrees for 10 MeV deuterons. At 80 degrees all of the groups of charged particles from the above reactions are clearly resolved. The differential D–D elastic scattering cross-sections have been obtained for the same angles and for these angles the cross-sections per unit solid angle in the centre-of-mass system are in the ratios of 1·00 : 0·51 : 0·42, respectively. Only one group of protons is observed from the $D(d, H)H^3$ reaction, thus indicating that the H^3 nucleus is not formed in an excited state for the energy region investigated when He^4 is the compound nucleus. A.

539.172.13

1988. Angular distribution of α-particles from the Li^7 (p, α) He^4 reaction. L. H. MARTIN, J. C. BOWER, D. N. F. DUNBAR AND F. HIRST. *Aust. J. Res. Sci. A*, **2**, 25–38 (*March*, 1949).

A description is given of a 1 MV electrostatic generator and ancillary equipment which has been used to study the asymmetry in the angular distribution of α-particles from the $Li^7(p, \alpha)He^4$ reaction. The angular distribution of the α-particles is given by the expression $Y(\theta) = Y(90°)[1 + A(E)\cos^2\theta + B(E)\cos^4\theta]$, where $A(E)$ and $B(E)$ are functions of the proton energy. The form of the expression implies the existence of both p and f protons in the nuclear reaction. A.

539.172.13

1989. Theory of the lithium two-alpha-reactions. II. Angular distribution of $Li^6(d, \alpha)\alpha$. R. RESNICK AND D. R. INGLIS. *Phys. Rev.*, **76**, 1318–23 (*Nov.* 1, 1949).

An analysis is presented of the variation of the intensity of alphas from $Li^6(d, \alpha)\alpha$ with angle and energy. This variation has been observed to have the form $1 + A(E)\cos^2\theta + B(E)\cos^4\theta$, as in the case of $Li^7(p, \alpha)\alpha$ for which an analysis has already been given [Abstr. 2938 (1948)]. For $Li^6(d, \alpha)\alpha$ it is again the Bose statistics and consequent even parity of the alphas that makes analysis possible. It is assumed that Li^6 has even parity so that only $s, d, \ldots$ deuterons are relevant here, in contrast to $Li^7(p, \alpha)\alpha$ in which $p, f, \ldots$ protons are involved. The two analyses differ also in the spin combinations, but are similar in the assumption of only two contributing states of the compound nucleus, with angular momentum quantum numbers 0 and 2. An expression for the energy variation of the angular distribution in $Li^6(d, \alpha)\alpha$ is derived from the dispersion formula and the treatment with two sharp levels is compared with that for one sharp and one broad level. The latter is found simpler and adequate for obtaining agreement with the experimental $A(E)$ and $B(E)$. After recognizing limitations on the parameters consistent with order-of-magnitude estimates of the matrix elements involved, it is found that the theoretical formulae rather naturally give the general form of the experimental results, including the feature that both $A(E)$ and $B(E)$ rise more slowly in the $Li^6(d, \alpha)\alpha$ reaction than in the $Li^7(p, \alpha)\alpha$ reaction as the bombarding energy is increased from zero, a consequence of the spherical symmetry of the entering s waves which participate in the Li^6 reaction only. A.

539.172.13

1990. 28·7-hour Ba^{135}. B. E. ROBERTSON AND M. L. POOL. Letter in *Phys. Rev.*, **76**, 1408–9 (*Nov.* 1, 1949).

Bombardment of enriched $Ba^{134}(NO_3)_2$ with 10 MeV deuterons yielded the 28·7-hr Ba activity, giving 0·28 MeV electrons, 0·30 MeV γ-radiation and Ba X-rays. Similar bombardments of enriched Ba^{132}, Ba^{135}, Ba^{136} and normal Ba gave a lower specific yield of the 28·7 hr activity. Fast neutrons from Li + d produced the highest 28·7 hr activity in the enriched Ba^{135}. The 28·7 hr decay was not observed when CsCl was bombarded with 10 MeV deuterons or 20 MeV α-particles, thus ruling out assignment to Ba^{133}, Ba^{134} or Ba^{136} which would be formed in $Cs^{133}(d, 2n)$, $Cs^{133}(d, n)$ and $Cs^{133}(\alpha, p)$ reactions respectively. Consequently the activity is attributed to an isomer of Ba^{135} formed by $Ba^{134}(d, p)$ and $Ba^{135}(n, n)$. L. R. SHEPHERD

539.172.13 : 539.185

1991. A photographic study of neutrons from Al + H^2. R. A. PECK, JR. *Phys. Rev.*, **76**, 1279–82 (*Nov.* 1, 1949).

The (d, n) reaction on Al has been studied using Eastman NTB emulsions. 2 200 head-on recoil tracks are plotted, and 10 groups identified (with widths and intensities), extending up to 9 MeV excitation of the product Si^{28} nucleus. The first two excited levels, at 1·8 and 4·5 MeV, agree with γ-ray energies and inelastic scattering. The reaction Q value (9·08 ± 0·20 MeV) determines the mass difference $Si^{28} - Al^{27} = +0{\cdot}99605 \pm 0{\cdot}20 \times 10^{-3}$ mass unit. A.

539.172.3

1992. A model of Be^9_4. V. DE SABATA. *Nuovo Cim.*, **6**, 368–73 (*Sept.*, 1949) *In Italian.*

The cross-section by photodisintegration of $_4Be^9$ is calculated, treating the nucleus as a two-body system.

The bond of the so-called "optical" neutron is represented by means of two rectangular potential holes, that is, assuming that besides the bulk of the nuclear forces, which have short range, there is a weak tail so that these forces have also a wider range. It is then possible to justify a min. found experimentally for the cross-section, near the photoelectric threshold. A.

539.172.3

1993. High-energy photo-disintegration of the α-particle. Y. NISHIDA AND M. NOGAMI. Letter in *Progr. Theor. Phys.*, **4**, 394–6 (*July–Sept.*, 1949).

This has been calculated using a Volz type of potential, neglecting tensor forces, for 2 different ranges, over the energy interval 100–250 MeV. The cross-section decreases rapidly with increasing range, but relatively slowly with increasing energy. G. J. KYNCH

539.172.3

1994. Photo-neutrons from neutron capture gamma rays. B. HAMERMESH AND A. WATTENBERG. Letter in *Phys. Rev.*, **76**, 1420–1 (*Nov.*, 1949).

Photoelectrons were ejected from D_2O, Pb, Bi, Hg and LiF by γ-rays, by the capture in Cl, Cd, Au and Fe of thermal neutrons from a heavy water pile. The fast photoneutrons were detected in a BF_3 chamber surrounded by paraffin, using Cd difference measurements, the counter being well shielded from fast pile neutrons. Cl capture γ-rays gave the greatest yields in most cases. No neutrons were observed from Fe, Al or Cd. L. R. SHEPHERD

539.172.3

1995. On the photo-disintegration of the deuteron. H. ENATSU AND Y. TAKANO. Letter in *Progr. Theor. Phys.*, **4**, 375–6 (*July-Sept.*, 1949).

Cross-sections at 3 energies are calculated for 3 types of square well potential in the ^3P state. G. J. KYNCH

539.172.3

1996. The photo-disintegration of the deuteron. I. F. E. HANSSON AND L. HULTHÉN. *Phys. Rev.*, **76**, 1163–5 (*Oct.* 15, 1949).

The photo-magnetic and photoelectric cross-sections have been calculated for γ-energies 2·62, 2·76 and 6·2 MeV, using different values of the deuteron binding energy (2·19 and 2·24 MeV). The calculations were carried out for a symmetrical theory with meson potential (Møller–Rosenfeld theory), the corresponding neutral theory (ordinary force) and a third version with no ^3P-interaction. Non-central forces were neglected. Results are given for two ranges, equivalent to meson masses 200 and 300. A.

539.172.3 : 539.185

1997. Angular distribution of neutrons from the photo-disintegration of the deuteron. F. GENEVESE. *Phys. Rev.*, **76**, 1288–94 (*Nov.* 1, 1949).

The angular distribution for γ-rays of 2·76 MeV energy has been investigated under conditions requiring no corrections for neutron scattering by the walls or by the heavy water. Inverse square law tests using balloon suspension indicated the clearance required for which the apparatus was free of the effects of scattering. The weighted ratio of the photo-magnetic to the photoelectric cross-sections was found to be $0{\cdot}295 \pm 0{\cdot}036$. A.

539.172

1998. On the delayed neutron emitter $_7N^{17}$. R. CHARPIE, K.-H. SUN, B. JENNINGS AND J. F. NECHA *Phys. Rev.*, **76**, 1255–6 (*Oct.* 15, 1949).

The Q-values of simple nuclear reactions by which N^{17} could be formed were calculated. The reaction $O^{17}(n, p)N^{17}$, Q-value $-7{\cdot}9$ MeV, was investigated. Neutrons of known max. energy were formed by bombarding thick C and LiF targets with 14 Me deuterons from a cyclotron. A water target was bombarded by these primary neutrons, and the N^{17} formed recognized by observing that delayed neutrons with a period of $4{\cdot}5 \pm 1$ sec were emitted after the cyclotron beam was shut off. A reduction in yield by a factor 15 was observed when the neutrons from a C target were used instead of LiF neutrons due to the much smaller number of neutrons with energies > 8 MeV, from a C target. The cross-section for the reaction $O^{17}(n, p)N^{17} \sim 10^{-26}$ cm^2. The reaction $O^{18}(\gamma, p)N^{17}$, Q-value $-15{\cdot}9$ MeV, is not involved since a thick Pb shield around the cyclotron target reduced the yield of N^{17} by the same proportion as the measured reduction of the primary neutrons. J. HUGHES

539.172.4

1999. The transient regime of nuclear reactors. I C. SALVETTI. *Nuovo Cim.*, **6**, 301–26 (*Sept.*, 1949) *In Italian.*

The transient behaviour of a nuclear chain reactor is studied without considering the effects of delayed neutrons. The density equation of thermal neutrons is integrated in two distinct cases; in a "static approximation," where the finite slowing-down time of the neutrons is not considered, and in a "non-static approximation" where such a time is considered. It is found that, for chain reactors of common type, the slowing-down time is not very important in determining the transient behaviour of the reactor. The periods of the harmonics in which neutron density may be expanded and their dependence on the reactor's dimensions are deduced. A.

539.172.4

2000. On the possibility of producing a divergent chain reaction in a uranium-carrying material. H. HALBAN, F. JOLIOT AND L. KOWARSKI. *C.R. Acad. Sci., Paris*, **229**, 909–14 (*Nov.* 7, 1949) *In French.*

Historical. The original paper was deposited under seal, Oct. 30, 1939, and is now published at the request of the authors.

539.172.4

2001. Perturbation theory in neutron multiplication problems. K. FUCHS. *Proc. Phys. Soc., Lond. A*, **62**, 791–9 (*Dec.*, 1949).

The perturbation theory for neutron diffusion problems in the one group theory is developed systematically. The multiplication of a neutron source inside a fissile system is discussed and the multiplication factor for a near critical system is derived as a function of the position of the source. Isotropic and anisotropic sources are considered. A few practical applications of the theory are discussed. A.

539.172.4

2002. Instrumentation for a nuclear reactor. V. L. PARSEGIAN. *Nucleonics*, **5**, 76–8 (*Oct.*, 1949).

539.172.4

2003. Kinetic energy release in fission of U^{238}, U^{235}, Th^{232}, and Bi^{209} by high energy neutrons. J. JUNGERMAN AND S. C. WRIGHT. *Phys. Rev.*, **76**, 1112–16 (*Oct.* 15, 1949).

The ionization produced by single fission fragments was observed in an ionization chamber using electron collection. If fission is induced by 90 MeV neutrons, the distribution of kinetic energy of the fission fragment v. the number of fragments is found to have a single peak in contrast to the double-peaked curve corresponding to the fission made by thermal neutrons. Fission induced by 45 MeV neutrons gives a distribution in which 2 peaks appear. The dip between the 2 peaks is about 20% of the height of the peaks. The mean kinetic energy is found to be 80 ± 2 MeV for U^{238}, 82 ± 1·5 MeV for U^{235}, 82 ± 2 MeV for Th^{232}, and 71 ± 2 MeV for Bi^{209} in the case of fission produced by 90 MeV neutrons. The mean kinetic energy is 79 ± 3 MeV for U^{238} and 84 ± 3 MeV for Th^{232} if 45 MeV neutrons are used. The most probable kinetic energy of the fragment is 83 MeV for U^{238}, 80 MeV for U^{235}, 83 MeV for Th^{232} and 75 MeV for Bi^{209} in the case of fission produced by 90 MeV neutrons. The bearing of these observations on the mechanism of fission is discussed. A.

539.172.4

2004. The extraction and purification of xenon and krypton isotopes from neutron irradiated uranium. W. J. ARROL, K. F. CHACKETT AND S. EPSTEIN. *Canad. J. Res. B*, **27**, 757–62 (*Sept.*, 1949).

Both long-lived and stable isotopes of Kr and Xe are formed as the result of the slow neutron fission of U^{235}. A method is described for the extraction of these gases from massive neutron-irradiated U metal, for separating them from contaminating gases and from each other and measuring them in a McLeod gauge, the amounts of U being of the order of 50 g and the rare gases of the order of 10^{-3} cm³ at N.T.P. An accurate value of the ratio of fission Xe to fission Kr is given. Further experiments concern G–M counter measurements on the long-lived Kr isotope. A.

539.172.4

2005. Investigation of nuclear energy levels in lead. H. H. BARSCHALL, C. K. BOCKELMAN, R. E. PETERSON AND R. K. ADAIR. *Phys. Rev.*, **76**, 1146–50 (*Oct.* 15, 1949).

The total neutron cross-section of Pb was measured from 20 keV to 750 keV with an energy spread of 10 keV. Maxima were observed at 350, 525 and 720 keV, each maximum being preceded by a minimum. In the region surrounding these anomalies, measurements were carried out with a resolution of about 5 keV. An attempt was made to interpret the maxima as due to resonances corresponding to isolated levels in the compound nucleus Pb^{209}. No energy levels were resolved when similar measurements were carried out for Bi. A.

539.172.4 : 539.185

2006. Thermal neutron cross sections and related data. H. R. KROEGER. *Nucleonics*, **5**, 51–4 (*Oct.*, 1949).

A table of declassified nuclear data including:—total, scattering, transport and absorption cross-sections for thermal neutrons, average log. energy loss and average cosine of the scattering angle of fast neutrons, for nearly all the elements up to and including U. L. R. SHEPHERD

539.172.4 : 614.8

2007. Shielding from nuclear radiations. L. A. OHLINGER. *Nucleonics*, **5**, 4–15 (*Oct.*, 1949).

Reviews problems of designing shields against γ-radiations and neutrons emitted from nuclear reactors. Most of the γ-radiation is in the energy range 1–5 MeV, where the main absorption process is the Compton effect and mass absorption coeffs. are substantially the same for all substances. Advantage in absorption of γ-radiation lies with the dense heavy elements, since these produce the most compact shields of least weight. Neutrons leave reactors with various energies and must be slowed down before effective absorption is possible. H compounds have the best moderating properties, but absorption of neutrons by H produces highly penetrating γ-radiation. B is a poor moderator, but captures neutrons by an (n, α) reaction accompanied by comparatively soft γ-rays. A solution of a B compound in water would be a very efficient neutron shield combining good moderation and capture without the production of troublesome high energy γ-rays. A dense γ-ray shield of W or Fe in combination with B and H compounds would probably afford the best type of shielding in mobile reactors. Partial shielding may be permissible over portions of a reactor, if radiation escaping from such portions cannot reach personnel either directly or by scattering from surrounding materials. Absorption of radiation from high power reactors is accompanied by considerable heat production and cooling may be required at the inner surfaces of the shields. L. R. SHEPHERD

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

2008. On the lifetime of the neutral meson. S. HAYAKAWA. Letter in *Progr. Theor. Phys.*, **4**, 386–8 (*July–Sept.*, 1949).

Further experimental evidence is given for a lifetime of 10^{-11} sec for the neutral meson, based on the production of showers and bursts, by decay with the emission of two photons or an electron pair. G. J. KYNCH

539.18

2009. Erratum: The production of mesons by photons and electrons. H. FESHBACH AND M. LAX. *Phys. Rev.*, **76**, 689 (*Sept.* 1, 1949).

See Abstr. 509 (1950).

539.18

2010. Spontaneous decay rate of heavy mesons. II. L. I. SCHIFF AND D. L. WEISMAN. Letter in *Phys. Rev.*, **76**, 1266–7 (*Oct.* 15, 1949).

A theoretical discussion of points raised concerning divergent integrals in the authors' previous note [Abstr. 511 (1950)]. E. P. GEORGE

539.18

2011. Scattering of pseudoscalar charged mesons by nucleons. I. E. CORINALDESI AND G. FIELD. *Phil. Mag.*, **40**, 1159–71 (*Nov.*, 1949).

The cross-section for the scattering is evaluated by a perturbation method and is expressed as a series of powers of the coupling constant. The first term, $\propto g^4$, is finite, but the second term, $\propto g^6$, is divergent. The divergencies are analysed and interpreted as meson and nucleon mass-corrections and mesonic charge-corrections. The finite terms in the 6th-order correction for the cross-section are computed for mesons with momenta $p \ll \mu$. The 4th-order and 6th-order contributions to the cross-section, $d\sigma_4$ and $d\sigma_6$, are evaluated and their ratio is given in terms of g. L. S. GODDARD

539.18

2012. The spectrum of meson decay electrons. G. B. ZHDANOV AND A. A. KHAIDAROV. *Dokl. Akad. Nauk, SSSR*, **65** (*No.* 3) 287–9 (1949) *In Russian.*

Reports measurements of the absorption in C and Pb of the decay electrons from stopped mesons. The results are discussed in the light of possible decay schemes. E. P. GEORGE

539.18

2013. The mass of neutral mesons. A. SOKOLOV AND B. KERIMOV. *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 2) 199–201 (1949) *In Russian.*

Nuclear binding is discussed in terms of meson theory. Arguments are advanced supporting the existence of a neutral meson with mass $\sim 130\, m_e$. E. P. GEORGE

539.18

2014. On the use of subtraction fields and the life-times of some types of meson decay. J. STEINBERGER. *Phys. Rev.*, **76**, 1180–6 (*Oct.* 15, 1949).

The method of subtraction fields in current meson perturbation theory is described, and it is shown that it leads to finite results in all processes. The method is, however, not without ambiguities, and these are stated. It is then applied to the following problems in meson decay: Decay of a neutral meson into two and three γ-rays, into a positron-electron pair, and into another neutral meson and photon; decay of a charged meson into another charged meson and a photon, and into an electron (or μ-meson) and neutrino. The life-times are tabulated. The results are quite different from those of previous calculations, in all those cases in which divergent and conditionally convergent integrals occur before subtraction, but identical whenever divergences are absent. The results are discussed in the light of recent experimental evidence. A.

539.18 : 530.145

Meson theory. *See Abstr.* 1478, 1494–1501, 1513–14

539.18 : 537.539

2015. On the relations between the cosmic-ray mesons and nuclear mesons. I–II. Y. TANIKAWA. Two letters in *Progr. Theor. Phys.*, **3**, 314–15 (*July–Sept.*, 1948).

A classification of the properties and types of mesons is given to agree with the existing data. G. J. KYNCH

539.18 : 537.59

2016. Effects of scattering and absorption of meson on coincidence-anticoincidence measurements. R. D. RUSK AND A. ROSENBAUM. *Phys. Rev.*, **76**, 1166– (*Oct.* 15, 1949).

Effects due to absorption and scattering of cosmic ray mesons with respect to position and nature of various materials were studied with a coincidence anticoincidence counter. Pb, Fe and paraffin and combinations of them were used. The position of the material was found to account for large variations in the counting rate which could be > or < that with no absorber. Effects which had sometimes been previously reported by others to indicate the presence of neutral particles are shown to be largely due to the geometry and other incidental causes. There was, however, a small residual effect due to paraffin, > the statistical error, always in the direction which could be interpreted in terms of exchange of charge or the production of neutral rays. A.

539.18 : 537.591.15

2017. On the multiple production of mesons. S. HAYAKAWA. Letter in *Progr. Theor. Phys.*, **3**, 321–2 (*July–Sept.*, 1948).

The number of showers due to interaction between mesons and nuclear particles is calculated simply using a geometrical cross-section for collisions of nuclei and a multiplicity law of meson production $\phi(E, E') \propto E^r E'^s dE$ where E, E' are the incident and emergent particle energies. Best agreement with experimental transition curves is obtained assuming that $r + s = 0$, but the best value of r is not given. The agreement is better than that previously obtained [Abstr. 1152 (1948)]. G. J. KYNCH

539.18 : 539.152.1

2018. On the correlation between Yukawa particles and mesons. T. INOUI AND S. OGAWA. Letter in *Progr. Theor. Phys.*, **3**, 319–20 (*July–Sept.*, 1948).

It is shown that the scheme $p \to n + \pi$, $\pi \to \mu + \nu$, $e \to \pi + \nu$ agrees with nuclear forces and nuclear β-decay, π-μ-decay and capture of π-meson by the nucleus, with a suitable set of interaction constants. To give the correct life-time of the μ-meson an additional process needs to be postulated such as that ($\mu \to e + 2\nu$) suggested by Anderson [Abstr. 418 (1948)]. G. J. KYNCH

539.18 : 539.152.1

On the existence of light nuclear mesons. *See Abstr.* 1918

539.185

2019. Reproducibility of photo-neutron standards. L. F. CURTISS AND A. CARSON. Letter in *Phys. Rev.*, **76**, 1412–13 (*Nov.* 1, 1949).

Two similar standards were made consisting of 1 g of Ra at the centre of a Be sphere 4 cm in dia. The corrected neutron intensities from the sources were identical within the limits of measurement of the Ra and Be. This type of neutron source is ⅓rd as efficient as the $RaBeF_4$ source [Abstr. 3472 (1949)] but is simpler to produce. L. E. MUSSELL

539.185

2020. On magneto optics of neutrons and some related phenomena. O. HALPERN. *Phys. Rev.*, **76**, 1130–3 (*Oct.* 15, 1949).

Formulae are derived describing the phenomenon

f total reflection of neutrons by a ferromagnet in dependence on the state of magnetization. It is hown how experiments of this kind can give informa- ion concerning the magnetic interaction between eutrons and atomic magnetic moments. A method o obtain well-polarized neutron beams with an ntensity loss of only 50% of the primary beam is outlined. The effect of pure magnetic scattering and ts influence on the transmission effect is discussed; n experimental arrangement for its observation is described. The significance of the approach to saturation in the single transmission effect is dis- cussed in connection with the saturation theory of ferromagnets. Remarks are made concerning the possibility of detecting wall effects of magnetic domains through depolarization of neutron beams.

A.

539.185

2021. Small angle diffraction of neutrons and similar wave phenomena. O. HALPERN AND E. GERJUOY. *Phys. Rev.*, **76**, 1117–29 (*Oct.* 15, 1949).

A study of the diffraction of waves under very small angles is presented; the diffraction objects are ideal microcrystals, crystallites, assemblies of poly- crystals and amorphous bodies. The diffraction cross-section was found to depend in a very sensitive way on the angle of scattering and on the nature and orientation of the scattering object. The most significant result found consisted in the observation that the integral cross-section of the diffraction object is in general not $\propto$ the number Z of atoms contained in the scatterer but to a higher power ($Z^{4/3}$ or $Z^{7/6}$). The results are applied to the interpretation of a number of experiments on the small angle scattering of neutrons and of light waves; possible effects on the polarization of neutrons are also discussed. A.

539.185

2022. Reflection and polarisation of neutrons by magnetised mirrors. D. J. HUGHES AND M. T. BURGY. Letter in *Phys. Rev.*, **76**, 1413–14 (*Nov.* 1, 1949).

By measurement of the intensity of scattering of neutrons for various critical angles, by a ferro- magnetic mirror magnetized in the direction of neutron propagation, it is shown that the form of the neutron-electron magnetic interaction proposed by Dirac agrees with experiment, two intensity peaks being observed. Neutrons from the thermal column of the Argonne heavy water pile are used, being filtered through BeO to give a beam of wavelength $> 4{\cdot}4$ Å. It is also found that completely polarized neutrons may be obtained by reflection from mag- netized Co without monochromatization, since only one spin state will reflect, regardless of wavelength. Both polarizing and analysing mirrors are kept magnetized in parallel directions and the degree of polarization is measured by observing the change in intensity when the beam between the mirrors is depolarized by the insertion of a thin piece of unmagnetized Fe. J. THEWLIS

539.185 : 530.145

Magnetic interaction between neutrons and electrons. *See Abstr.* 1503

539.185 : 538.221

Detection of antiferromagnetism by neutron dif- fraction. *See Abstr.* 1867

539.185 : 539.172.13

A photographic study of neutrons from Al + H^2. *See Abstr.* 1991

539.185 : 539.172.4

Thermal neutron cross-sections and related data. *See Abstr.* 2006

539.185.9

2023. (n, γ) recoil effects in potassium chromate and dichromate. J. H. GREEN AND A. G. MADDOCK. Letter in *Nature, Lond.*, **164**, 788–9 (*Nov.* 5, 1949).

Crystals of K dichromate sealed in a silica ampoule in air at atmospheric pressure were irradiated with thermal neutrons. A small but definite Szilard–Chalmers separation occurs. The yield (12%) depends little, if at all, on the pH of the solution in which the irradiated dichromate is dissolved. The separation of Cr^{51} is unaffected by the quantity of carrier (chrome alum or chromic chloride) added, or the time which elapses between the addition of the carrier and its separation. In the case of K chromate the retention varied considerably with the pH of the solution in which the irradiated chromate was dis- solved. The effect can be used to prepare sources of Cr^{51} of high specific activity. The effect of heat on the metastable ions present was investigated by heating the irradiated sample to 480° for some time, then dissolving in water and measuring the retention. A definite fraction of the active atoms remains in a form which gives Cr^{+++} on dissolution in water. If irradiated chromate is dissolved in excess of K dichromate solution, the retention observed is equal to that found on dissolution of irradiated K di- chromate in solutions of the same pH. A. J. MEE

STRUCTURE OF SOLIDS 539.2

539.21

2024. Isothermal compositional order-disorder. I. Superstructure solid solutions in a salt system. A. GRENALL. *J. Chem. Phys.*, **17**, 1036–43 (*Nov.*, 1949).

539.215.4

2025. The graphical representation of the particle size distribution of loose materials. H. GESSNER. *Schweiz. Arch. angew. Wiss. Tech.*, **13**, 265–8 (*Sept.*, 1949) *In German.*

Sieve analysis can be used to determine the quantity of material within various size groups down to about 0·08 mm, and sedimentation is employed for the finer particles. The results may be plotted as quantity of material in the sample exceeding the sizes plotted along the abscissa; the sieve and sedimentation results are frequently plotted separately, and an additional curve is given showing the total result. When the slope of this curve is plotted against the particle size, a type of frequency curve is obtained which indicates the frequency with which particles of each size occur in the sample. Details are given of the graphical construction to obtain this type of curve, and the work is illustrated by examples.

A. C. WHIFFIN

539.215.6

2026. A study of the mechanism of sintering of metallic particles. J. H. Dedrick and A. Gerds. *J. Appl. Phys.*, **20**, 1042–4 (*Nov.*, 1949).

Single layers of spherical Cu particles have been sintered under varying conditions of time and temp. in a dry H_2 atmosphere. Analysis of the rate of interface contact between the particles has shown metallic sintering to be a diffusion process, in agreement with the theory of Kuczynski. The heat of activation of self-diffusion of Cu has been calculated and found to be 55 000 cal./mole. This is in close agreement with values obtained by the radioactive tracer method. A.

539.215.6

2027. A phenomenological theory of sintering. J. K. Mackenzie and R. Shuttleworth. *Proc. Phys. Soc. B*, **62**, 833–52 (*Dec.*, 1949).

Sintering occurs when powders are heated to temps. near their melting points. This paper deals with the rapid increase of density during the sintering of single substances. The increase of density cannot be explained by volume diffusion of vacant lattice sites or surface migration of atoms, but must involve macroscopic flow. The driving force for this flow is surface tension, and an equation connecting the rate of shear strain with the shear stress defines the resistance to deformation. The density of a compact is calculated as a function of the time for two different laws of deformation, (*a*) that for a solid with a Newtonian viscosity, and (*b*) that for a Bingham solid which has a yield point and a rate of shear strain $\propto$ the difference between the applied shear stress and a yield stress. The effect of gas in the pores is calculated in the case of the viscous law. The theory assumes that the pores are equal spheres and predicts that densification is uniform throughout a compact, independently of its shape and size, and suggests that gas pressures of a few atmos. applied to the outside of a compact may appreciably increase the rate of sintering. Relevant experiments and previous theories are examined critically, and it is shown that while the viscous model may explain the sintering of glasses it cannot explain that of metals. However, the experimental data can be explained by a model showing a yield point: on such a model the interaction of one pore with its neighbours is vital, so that pores in powder compacts close and isolated pores do not. A.

539.234

2028. The structure and growth of evaporation LiF and NaCl films on amorphous substrates. L. G. Schulz. *J. Chem. Phys.*, **17**, 1153–62 (*Nov.*, 1949).

Thin films of LiF and NaCl were prepared by evaporation in a vacuum and studied by means of electron diffraction, electron microscopy, X-ray diffraction and optical methods. It was found that on amorphous substrates the films possessed a crystal orientation which varied with the film thickness. For both LiF and NaCl deposits thinner than 100 Å showed almost completely random structure but with a small amount of [100] preferred orientation. As the thickness was increased there was a change, first to completely random, and then to a very definite and strong preferred orientation which was [111] for LiF and [110] for NaCl. The extent of these orient tions both on the surface and in the interior of t film was studied in relation to crystal growth. T films are composed of loosely packed crystals together so as to give the characteristic orientati and with appreciable spaces where the crystals do n make contact. A less extensive study of 5 oth substances showed the following orientations: CaF [111]; KCl, [110]; MgF_2, [302]; NaBr and KB random or a vague [211]. MgF_2 was amorphous f deposits under 1 000 Å but became crystalline f greater thicknesses. Detailed consideration is giv to the comparison and interpretation of resul obtained by different experimental methods.

539.2

2029. Ultra-microtomy by a new method. S. B Newman, E. Borysko and M. Swerdlow. *J. Re Nat. Bur. Stand., Wash.*, **43**, 183–200 (*Sept.*, 1949).

Polymerization of *n*-butyl methacrylate monome is used as a rapid and simple means for embeddin fixed biological material. The solid resin provides a optically clear matrix for cutting very thin section one at a time, with a slightly modified conventiona rotary microtome. Advance of the embedde specimen toward the knife is obtained from th thermal expansion of a brass specimen holder These ultra-thin sections have uniform thickness large area and integrity of tissue structure. They ar suitable for producing transmission images at th higher magnifications of the conventional light phase-contrast and electron microscopes. Micro graphs and a bibliography are presented. A

539.26

2030. Interpretation of X-ray patterns of cold-worked metal. B. L. Averbach and B. E. Warren Letter in *J. Appl. Phys.*, **20**, 885–6 (*Sept.*, 1949).

An analysis of powder pattern line shapes for cold-worked α-brass in terms of the Fourier coeffs relating to cold work broadening, indicates that the r.m.s. stress is approximately isotropic. It is suggested that this method of analysis is applicable to other types of broadening. A. E. De Barr

539.264

2031. A direct method of determining preferred orientation of a flat reflection sample using a Geiger counter X-ray spectrometer. L. G. Schulz. *J. Appl. Phys.*, **20**, 1030–3 (*Nov.*, 1949).

The chief advantage of the method is that the experimental data may be used directly without corrections for changes in geometry during rotation of the sample. Beginning from an initial position identical with the usual reflection arrangement the sample is rotated about an axis defined by the intersection of the sample surface with the plane of the spectrometer. During this motion a randomly oriented sample of sufficient thickness will yield a constant counting rate because the absorption and effective scattering volume of the sample remain unchanged. As a result, no correction formula is required. The experimental arrangement requires 3 horizontal slits; 2 are used to collimate the incident beam, and the third is placed in front of the counter. A mathematical analysis of the optical elements of the arrangement is given together with the results from a practical application. A.

539.264

2032. Determination of preferred orientation in flat transmission samples using a Geiger counter X-ray spectrometer. L. G. SCHULZ. *J. Appl. Phys.*, **20**, 1033–6 (*Nov.*, 1949).

A method employing a diverging X-ray beam is described for the determination of preferred orientation in flat transmission samples with a Geiger counter X-ray spectrometer. It is shown that for a certain range of sample thickness the counting rate is independent of the rotation of the samples, and therefore, no correction formulae is required. A.

539.264

2033. The effect of cold work in metals on powder pattern intensities. B. L. AVERBACH AND B. E. WARREN. *J. Appl. Phys.*, **20**, 1066–9 (*Nov.*, 1949).

Using crystal-monochromated Cu $K\alpha$ radiation and a Geiger counter spectrometer, integrated intensity measurements have been made for powder samples of cold-worked and annealed α-brass. The effect of cold work is to increase the integrated intensity of the strong lines and make practically no change in the weak lines. The increase for the strong lines is presumably due to a reduction in extinction. Measurements were made of the (400) reflection on a cold-worked sample and on an annealed sample held at high temp. to demonstrate the difference between the effects of cold work and temp. vibration. A.

539.27

2034. A technique for the preparation of grease or solid samples dispersed in grease-like media for examination with the electron microscope. A. Y. MOTTLAU. *J. Appl. Phys.*, **20**, 1055–9 (*Nov.*, 1949).

539.27 : 539.13

2035. Internal motion and molecular structure studies by electron diffraction. I. L. KARLE AND J. KARLE. *J. Chem. Phys.*, **17**, 1052–8 (*Nov.*, 1949).

A procedure has been developed for the determination of molecular structure by electron diffraction which yields accurate intensity data and obviates the necessity for visual examination of the diffraction photographs. The theory for computing radial distribution curves has been extended to permit accurate curves to be obtained from scattering data covering only a restricted range of angle. From this method, it is possible to obtain not only equilibrium distances but also the probability distributions for the vibrational motion between pairs of atoms in a molecule. The procedure has been applied to CCl_4 and CO_2 and when comparisons may be made with spectroscopic results, satisfactory agreement is obtained. A.

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31

2036. On the statistical theory of rubber-like elasticity. T. SAKAI AND A. ISIHARA. *J. Coll. Sci.*, **4**, 71–7 (1949).

A method of calculation based on the principles of statistical mechanics and making no use of the Gaussian law of distribution is presented. The results are the same as those obtained by James [Abstr. 3405 (1947)]. The various theories of rubber-like elasticity are discussed.

RUBBER RESEARCH ASSOCIATION

539.31

2037. Simple presentation of network theory of rubber with a discussion of other theories. H. M. JAMES AND E. GUTH. *J. Polymer Sci.*, **4**, 153–82 (1949).

The approximations implicit in the use of the Gaussian network model for soft vulcanized rubber are discussed. It is shown that the form of the stress-strain curve can be derived for this model simply and without special assumptions about the form or behaviour of the network. The common assumptions that the network junctions are fixed, or can be treated as fixed, is discussed. It is shown that this picture of the situation is unrealistic; the junctions have a Brownian motion comparable to that of any portion of the intervening molecular segments. The introduction of this assumption is not generally admissible, but it will not affect the outcome of certain types of calculation; in particular, one can foresee that it need not affect the calculated form of the stress-strain curve. A simple calculation of the network entropy on this basis is given. Wall's theory of rubber [see Abstr. 1308 (1942); 398 (1944)] is analysed. It is shown that Wall's postulates are not consistent with the network structure of rubber, and in general lead to different results.

RUBBER RESEARCH ASSOCIATION

539.31

2038. An anomaly in the classical theory on infinitesimal deformation. K. H. SWAINGER. Letter in *Nature, Lond.*, **164**, 888 (*Nov.* 19, 1949).

539.312

2039. Propagation of transverse waves in viscoelastic media. F. T. ADLER, W. M. SAWYER AND J. D. FERRY. *J. Appl. Phys.*, **20**, 1036–41 (*Nov.*, 1949).

In calculating elastic constants of viscoelastic media from transverse wave propagation, it has been customary heretofore to assume a plane disturbance in a medium of infinite extent. Equations have now been derived for conditions which approach much more closely the experimental arrangement, namely, propagation from a finite source plate in a rectangular cell, and representative numerical calculations have been made. The new theory shows that the finite dimensions of cell and source should have very little influence on the wavelength as determined from observations of strain double refraction, but the attenuation should be perceptibly different from that of the plane wave case. Experimental data confirm these conclusions. Nevertheless, the simple plane theory is adequate within present experimental error for the majority of cases. Only in certain specified ranges of mechanical consistency will it be necessary to apply corrections taking into account the sizes of the cell and source. A.

539.312

2040. Dynamic properties of polymeric materials. B. A. DUNELL AND A. V. TOBOLSKY. *J. Chem. Phys.*, **17**, 1001–2 (*Oct.*, 1949).

A model with a rectangular distribution of relaxa-

tion times on a log plot leads to a simple relation between $\eta_{dyn}\omega$ and ε_0 (strain at which stress relaxation occurs) if the stress relaxation/log time curve is linear. The calculated values of $\eta_{dyn}\omega$ are compared with experiment for rubber and various textile fibres. J. E. CAFFYN

539.32

2041. Elastic constants of corundum. J. BHIMASENACHAR. Letter in *Curr. Sci.*, **18**, 372–3 (*Oct.*, 1949).

539.32 : 541.182.5

2042. The elastic properties of silica gels. L. A. MUNRO, J. G. MCNAB AND W. L. OTT. *Canad. J. Res. B*, **27**, 781–90 (*Oct.*, 1949).

The effect of age, concentration and temp. on the Young's modulus of acid and alkaline silica gels has been measured by a compression method. For the range of concentrations used the Young's modulus is not independent of load. The modulus increases with age of the gel and with concentration. Hurd's criterion of the time of set (tilted rod method) has been evaluated in terms of absolute units. The effect of temp. on the elastic properties is different for acid and alkaline gels. The Young's modulus values for the former (*p*H 5·6) increase, while for the alkaline gel (*p*H 8·2) of the same silicate concentration the values decrease with increasing temp. The modulus for the alkaline gel is > for the acid gel at the lower temps. A mechanism is suggested to explain these differences. A.

539.32 : 548.0

2043. Determination of elastic constants from diffuse reflexion of X-rays. G. N. RAMACHANDRAN AND W. A. WOOSTER. Letter in *Nature, Lond.*, **164**, 839–40 (*Nov.* 12, 1949).

Measurements of the thermal scattering of X-rays with a monochromator and Geiger-counter spectrometer already described [Abstr. 5456 (1949)] and interpreted by means of Jahn's theory [Abstr. 1091 (1942)] lead to the following values of the elastic constants, all in 10^{11} dynes cm^{-2}.

	c_{11}	c_{12}	c_{44}
KBr	3·5	0·56	0·60
KCl	4·0	0·67	0·71
$NaClO_3$	4·8	1·5	1·2
PbS	9·4	3·5	2·4
$C_6H_{12}N_4$	1·5	0·3	0·7

The name *rekha* (Sanskrit for ray) is proposed for a line passing through a point of the reciprocal lattice and defined by given direction cosines.

A. J. C. WILSON

539.373

2044. Interferometric study of slip bands on metal crystals. S. TOLANSKY AND J. HOLDEN. *Nature, Lond.*, **164**, 754–5 (*Oct.* 29, 1949).

By the use of multiple-beam interference fringes in reflection, slip bands produced by mechanical strain on the surfaces of Al and Sn are studied. In Al, steps are found with average value approximately 900 Å. The blocks between slip zones appear to have tilted through angles of the order of 6 minutes of arc. In Sn, high definition is obtained by securing good optical surfaces through a casting technique. Observ slip steps range from 50 to 350 Å (± 20 Å).

S. TOLANS

539.3

2045. Note on some plastic flow effects in ste O. H. CLARK AND E. M. LYMAN. *J. Appl. Phy* **20**, 884–5 (*Sept.*, 1949).

The plastic flow effects which take place when tv steel rods are pressed together at right angles a studied. The deformations produced are evaluat by the use of interference fringes. Elastic recove effects are calculated, using Prussian blue as indicator to reveal recovery. Measurements a reported for deformations between (*a*) like cylinde (*b*) cylinders of different hardness. The measurir error is of the order of ½ a light wave. S. TOLANSK

539.3

2046. Viscoelastic and photoelastic properties polystyrene above its softening temperature. L. NIELSEN AND R. BUCHDAHL. Letter in *J. Chem. Phys* **17**, 839–40 (*Sept.*, 1949).

Birefringence measurements on polystyrene film 110°C were made (*a*) while the film was extended constant load, (*b*) during relaxation of stress befor and after cycling. The ratio of birefringenc (*A*/mil) to stress was approx. constant. Cyclin affects the slope of the stress and birefringence/tim curves. Semi-permanent network structure due t interlocking of chain segments is proposed to explai the phenomenon. J. E. CAFFY

539.37

2047. New interpretation of the *n*-power law i plastic deformation. H. I. FUSFELD. *J. Appl. Phys* **20**, 1052–5 (*Nov.*, 1949).

It is shown that the *n*-power law describing a tru stress-strain curve, normally written as $S = k\delta^n$, ca be placed in the form $S = S_0(e\delta/n)^n$ where S_0 is th engineering tensile strength. The application of thi new expression to tensile curves is discussed. A plo of S/S_0 as a function of n, for a fixed value of th logarithmic strain δ, provides a general description of the behaviour of all materials in plastic deforma tion. Experimental data from the literature are in good agreement with the curves. A

539.389.4

2048. Physical aspects of rubber elasticity.— Hysteresis. J. CLOUAIRE. *Rev. Gén. Caoutch.*, **26** 626–30 (1949) *In French.*

According to the temp., rate and magnitude of deformation, several different phenomena may cause hysteresis of rubber under mechanical stresses varying with time, e.g. permanent set, internal friction and crystallization. For rapid deformations of small amplitude such as exist in a state of vibration, the observed loss of energy results mainly from internal friction. Slow deformations are considered also.

RUBBER RESEARCH ASSOCIATION

539.501

2049. Report on fundamental experimental methods in rheology. F. R. EIRICH. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948 (*Pt IV*) 3 (1949).

Author enumerates rules and precautions in selecting experimental methods, discusses macroscopic and microscopic pictures of deformation and

plains uses of mechanical models. The merits of large number of individual methods of rheological sting are also considered.

BRITISH RHEOLOGISTS' CLUB

539.501

050. Introductory remarks on the problem of omenclature in rheology. J. M. BURGERS. *Proc. 1st nt. Congr. Rheol., Scheveningen*, 1948 (*Pt I*) 3 (1949).

539.501

051. Psychophysical aspects of rheology. G. W. COTT BLAIR. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948 (*Pt I*) 95 (1949).

539.501

052. Rheology and the constitution of matter. . M. FREEMAN AND K. WEISSENBERG. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948 (*Pt II*) 12 (1949).

The materials studied in rheology range from oarse-grained, in which a discontinuous structure is pparent, to the fine-grained, which appear continuous. The coarse-grained may be made to give ombinations of mechanical properties not easily vailable in the fine-grained, and because of the isible nature of their structure, their behaviour may help to elucidate the hidden structure of the apparently ontinuous materials. In comparing the behaviour of the various materials, particular attention has been paid to the powers of strain recovery in both shear and volume. Sponges and aggregates of fibres have been compared with certain sols and gels; both types show a large power of strain recovery and a close resemblance in those phenomena which depend upon shear properties. In other respects their properties diverge on account of differences in compressibility. These similarities and differences are illustrated by photographs of various materials under torsion.

BRITISH RHEOLOGISTS' CLUB

539.501

2053. The rheology of suspensions. A. DE WAELE AND E. W. J. MARDLES. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948 (*Pt II*) 166 (1949).

539.501

2054. Relation between stress and strain in complicated systems. M. REINER. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948 (*Pt IV*) 44 (1949).

Materials may deviate from the classical laws of elasticity, plasticity or viscosity because the coeffs. in the idealized stress/strain relations are not strictly constants. More generally, the properties of materials will be combinations of elasticity, plasticity and viscosity which might be represented symbolically by a model of elastic springs and viscous dashpots coupled in series and parallel. A concise notation for complicated models is introduced, and several possible combinations are enumerated. The possibility of volume flow (plastic or viscous) as well as shear flow is emphasized. Dilatancy, finite strain and cross-elasticity are further complications of which rheological theory must take account.

BRITISH RHEOLOGISTS' CLUB

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.126 : 536.46

Spectroscopic investigation of the carbon monoxide–oxygen reaction. *See Abstr.* 1705

ELECTROCHEMISTRY 541.13

541.132.3

2055. A precision electronic *p*H control. J. E. BREEZE. *Nat. Res. Coun. Can. Publ.* (*No.* 1823) 10 *pp.* (1949).

A complete precision *p*H control system suitable for laboratory use is described briefly. The mechanism of operation and a detailed circuit description are given for the electronic control portion of the whole system. The instrument described makes possible *p*H control of biological reactions to an accuracy of 0·01 *p*H intervals and *p*H measurement or comparison to an accuracy of 0·002 *p*H intervals. A.

541.135.85 : 535.434

Light scattering by charged particles in electrolyte solutions. *See Abstr.* 1683

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14

541.14

2056. The vapor-phase photo decomposition of hydrogen peroxide. D. H. VOLMAN. *J. Chem. Phys.*, **17**, 947–50 (*Oct.*, 1949).

541.14

2057. Diffusion in photo-chemical experiments: The photo-chemical decomposition of acetone. T. L. HILL. *J. Chem. Phys.*, **17**, 1125–31 (*Nov.*, 1949).

DISPERSIONS . COLLOIDS ADSORPTION 541.18

541.18.04

2058. The sedimentation and diffusion of small particles. C. N. DAVIES. *Proc. Roy. Soc. A*, **200**, 100–13 (*Dec.* 22, 1949).

The concentration of particles which settle and diffuse while in suspension in a fluid is given as a function of time and position for a dilute suspension which is initially uniformly dispersed in a wide vessel. It is assumed that all particles which strike the surfaces of the container will be absorbed. Solutions are obtained for a liquid with a free surface and also for a gas or liquid which entirely fills the space between two horizontal planes. The solutions occur as eigen-

function expansions and in integral form and numerical results are given for various circumstances. A.

541.18.047 : 534.321.9

Agglomeration of smoke, fog or dust particles by sonic waves. *See Abstr.* 1598

541.182.5 : 539.32

The elastic properties of silica gels. *See Abstr.* 2042

541.182.6 : 532.133

2059. Viscometry of settling suspensions with a rotational viscometer. H. DE BRUIJN AND P. G. MEERMAN. *Proc. 1st Int. Congr., Scheveningen*, 1948 (*Pt II*) 160 (1949).

A Stormer viscometer was used to measure the viscosity of settling suspensions by calibration with Newtonian liquids of different viscosities and densities. (Density effects had to be studied because the system had to be maintained turbulent.) It was found that for coarse suspension viscosity increased with speed of rotation. An explanation is offered: the work necessary for maintaining the settling particles in suspension is the cause of this apparent increase in viscosity and a certain amount of evidence in support of this hypothesis is produced.

BRITISH RHEOLOGISTS' CLUB

541.182.6 : 537.226.2 : 532.133

Viscosity and dielectric constant of liquid dispersions and solutions. *See Abstr.* 1527

CHEMICAL STRUCTURE 541.4/.6

541.57

2060. The calculation of ionic resonance energies. R. G. PEARSON. *J. Chem. Phys.*, **17**, 969–71 (*Oct.*, 1949).

541.64 : 532.582.7

The shape of macromolecules in solution and the interrelationships of their hydrodynamic parameters. *See Abstr.* 1544

541.64 : 534.22

2061. Rate of propagation of ultrasonic waves in macromolecules. G. NATTA AND M. BACCAREDDA. *J. Polymer Sci.*, **3**, 829–33 (1948).

The velocity of ultrasonic waves in various hydrocarbons and in some polymers has been measur The polymers were polythene, polyisobutylene, pc alpha-butene, polystyrene and polyvinyl isobu ether. It was found that the ratio (R) of the ult sonic velocity to the density of various polymers related to the form of the molecules: In compoun with a straight paraffin chain, R increases w increasing molecular weight; in cross-linked co pounds with ethyl and methyl groups, R is practica a constant for all compounds up to a molecu weight of 15 000; in compounds containing la radicals in the side chain, R is much smaller for hi polymers than for low-molecular compounds; and general, the compressibility is higher for polym with frequent and large cross linkages than compounds with little or no cross-linking.

RUBBER RESEARCH ASSOCIATI

541.64 : 535.4

Light scattering techniques for measuring molecu weights of high polymers. *See Abstr.* 1683

CHEMICAL ANALYSIS 543/545

545.

2062. On the use of the a.c. carbon arc for quantit tive spectrographic analysis. F. ROST. *Z. ange Phys.*, **1**, 136–9 (*July*, 1948) *In German.*

The method is briefly discussed with example The determination of Al, Ca, Fe, Mg and Ti quartz sand gave results of 11 to 15% accuracy, wit lower limits of estimation of 0·02, 0·01, 0·005, 0·00 0·001% respectively. In the determination of im purities in coke the material was mixed with a know amount of V_2O_5, and V lines used in the estimation Al, Ca, Fe, Mg, Si and Ti, with 20 to 40% accurac and lower limits of 0·05, 0·02, 0·05, 0·005, 0· 0·005% respectively. To estimate Mo in B the a was photographed only after burning till Al, C Mg, Si and Fe had been removed, and the Mo lin 3 170·34Å compared with its background on th plate. In this case accuracy was 35% in the rang 0·003 to 0·1% Mo. S. T. HENDERSO

CRYSTALLOGRAPHY 548

548.0 : 535 : 537.226.2

Optical behaviour of $BaTiO_3$ single-domain crystals. *See Abstr.* 1755

548.0 : 537.228.2 : 621.396.611.21

2063. A new crystal cut for quartz with zero temperature coefficient. E. J. POST. *Tijdschr. Ned. Radiogenoot.*, **14**, 147–57 (*Sept.*, 1949) *In Dutch.*

The new quartz crystal, for which the name HT-cut is proposed, is a rotated y-cut, related to the AT- and BT-cut and intended for use in the 400–1 000 frequency range. The properties, compared to those of the AT- and CT-cuts for the same interval of kc/s frequency are: (1) the mass of this resonator is generally smaller than that of a corresponding AT-cut and larger than that of a corresponding CT-cut; (2) the resonator may be mounted by soldering spring to the nodes of the crystal and therefore has frequency stability and independence from mechanical shock (3) as a consequence of the larger mass the damping i somewhat smaller than that of a correspondin CT-cut; (4) the crystal is free of false responses in a area of about 10% above and below the mai resonance; (5) the self-inductance can be predicte with a fair amount of accuracy. For an averag resonator it is about 3–4× smaller than that of corresponding CT-cut. A

548.0 : 537.52

Electric breakdown in ionic crystals. *See Abstr* 1779

548.0 : 537.533.7

The passage of slow electrons through alkali halide crystals. *See Abstr.* 1786

548.0 : 539.32

Determination of elastic constants from diffuse reflection of X-rays. *See Abstr.* 2043

548.54

2064. The effect of crystal habit modification on the setting of inorganic oxy-salts. J. WHETSTONE. *Disc. Faraday Soc.* (*No.* 5) 261–6 (1949).

Intergranular bonding throughout a packed salt often causes hard caking. Crystal habit modification of a granular salt may ensure that the solid bridges in the caked material are deposited in a fragile condition, the hardness of the bulk product remaining low after appreciable solution and recrystallization. Tables are given of the effect of dye treatment on setting of some inorganic salts. Dyes producing extreme habit modifications were most effective in controlling the setting tendency. J. A. FRANKS

548.54

2065. Habit modification in crystals as a result of the introduction of impurities during growth. H. E. BUCKLEY. *Disc. Faraday Soc.* (*No.* 5) 243–54 (1949).

The introduction of impurities in crystals growing in aqueous solution may cause—(1) formation of parallel growths, (2) deposition of ionic impurities in parallel positions in layers and zones, (3) modification of the crystal habit. No direct relationship is evident between deposition of impurity on certain faces, and habit modification. Many examples are given of the effects of dyes on habit modification.

J. A. FRANKS

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

2066. The propagation of order in crystal lattices. H. SHIMAZU. *Progr. Theor. Phys.*, **4**, 201–8 (*April–June*, 1949).

Approximate series are developed for the long-range and short-range order parameters as the functions of the temp. and nearest-neighbour interaction energies. The first 5 terms coincide with van der Waerden's exact series [*Z. Phys.*, **118**, 473 (1941)]. A. J. C. WILSON

548.7

2067. Dynamical theory of the vibration spectra of crystals. VI. The zinc sulphide structure. K. G. RAMANATHAN. *Proc. Indian Acad. Sci. A*, **28**, 459–62 (*Nov.*, 1948).

Expressions for the frequencies of the 9 normal modes of the ZnS structure are derived in terms of 10 force constants taking account of the interaction of each atom with its 16 nearest neighbours. The constants of the formulae are connected by two relations. W. R. ANGUS

548.7 : 535.34

2068. Theory of the *F*-centers of coloured alkali halide crystals. I. Structure of the *F*-absorption bands. T. MUTO. *Progr. Theor. Phys.*, **4**, 181–92 (*April–June*, 1949).

The difficulties in solving the wave equation for an imperfect crystal are stated, the alkali halides providing the best subject for theoretical treatment. The nature of the *F*-centre responsible for the selective absorption of light is discussed and Tibbs's theoretical treatment [*Trans. Far. Soc.*, **34**, 506 (1938)] is considered to be over-simplified. Neglecting the mutual interaction of *F*-centres, the wave function and the intensity distribution of *F*-absorption bands are calculated. The effects of temp. on the max. intensity of the *F*-absorption band and corresponding frequency, ν_m, are discussed and for $T \gg \theta$ and $T \ll \theta$, the Debye temp., simple expressions for $h\nu_m$ are obtained. The results agree well with the experimental work of Pohl. C. A. HOGARTH

548.7 : 537.12

2069. Theory of polarons. S. I. PEKAR. *J. Exp. Theor. Phys., USSR*, **19**, 796–806 (*Sept.*, 1949) *In Russian.*

A polaron in an ionic crystal is investigated. Treating the ionic vibrations quantum-mechanically, and assuming their frequency so small that the state of the conduction electron may follow the ion movements, an adiabatic approximation is reached. It is assumed that the polaron dimensions greatly exceed the lattice constant, and that of the optical vibrations only long waves have an exchange effect with the polaron. Its effective mass is obtained and states of a continuous energy spectrum. Optical vibrations of ions scatter polaron waves; corresponding free path and mobility of polaron are calculated, they coincide at all temps. with those of charge carriers in semiconductors. At very low temps. mobility is determined by acoustical vibrations, and is finite even at absolute zero. Dissociation energy of polaron is same as in semiclassical calculations. J. JACOBS

548.7 : 539.132

Molecular rotation in sodium cyanide and sodium nitrate. *See Abstr.* 1902

548.733

2070. A β-filter furnace for elevated temperature single-crystal X-ray diffraction. E. G. STEWARD. *J. Sci. Instrum. Phys. Ind.*, **26**, 371–2 (*Nov.*, 1949).

An attachment for single-crystal X-ray cameras, enabling photographs to be obtained at elevated temps., is described. Heating is accomplished by passing an electric current through a cone of nickel foil (for Cu*K* radiation) which surrounds the specimen. At the same time the cone acts as a β-filter to the diffracted X-rays. A.

548.735.4

2071. The projection of crystal structure factors on the reciprocal lattice. D. MCLACHLAN, JR. AND C. L. CHRIST. *J. Appl. Phys.*, **20**, 829–31 (*Sept.*, 1949).

A discussion of the use of the wave addition method for making projections of the crystal structure factor, F_{hko}, upon the reciprocal lattice, in a fashion similar to that used in making electron density projections in real space, through the use of the "sand machine" and devices operating on similar principles, has been developed. A.

548.735.44

2072. Erratum: Determination of relative phases of Fourier coefficients from X-ray diffraction data. D. MCLACHLAN, JR. Letter in *J. Appl. Phys.*, **20**, 1011 (*Oct.*, 1949). See Abstr. 6559 (1949).

548.735.7

2073. On the immediate measurement of irregular lattice distortions with the Geiger counter. R. FRICKE AND A. SEITZ. *Naturwissenschaften*, **36** (*No.* 5) 156 (1949) *In German.*

Reduction in intensity of diffraction maxima of poorly crystalline materials (e.g. oxides prepared by low-temp. dehydration of hydroxides) is interpreted as lattice distortion comparable with that due to heat motion. Geiger-counter measurements give $\sim 0{\cdot}1$ Å for the r.m.s. displacement of the atoms, in fair agreement with earlier photometric measurements [Fricke and Gwinner, *Z. Phys. Chem.*, **183 A**, 165 (1938)]. A. J. C. WILSON

548.736.3

2074. Crystal structure of the third form of phosphorus pentoxide. C. H. MACGILLAVRY, H. C. J. DE DECKER AND L. M. NIJLAND. Letter in *Nature, Lond.*, **164**, 448–9 (*Sept.* 10, 1949).

X-ray determination of structure gives *Pnam* ($= D_{2h}^{16}$) $a = 9{\cdot}23$ Å; $b = 7{\cdot}18$ Å; $c = 4{\cdot}94$ Å. A table gives the co-ordinates of the atoms in the unit cell. This corrects the conclusion of Hill, Faust and Hendricks [Abstr. 2447 (1943)] that the structure was tetragonal. R. B. SHEPHERD

548.736.5

2075. On the crystal structure of KUO_2VO_4 (synthetic anhydrous carnotite). I. SUNDBERG AND L. G. SILLÉN. *Ark. Kemi*, **1**, *Paper* 42, 337–51 (1949).

548.736.5 : 537.22

2076. Symmetry changes in barium titanate at lo temperatures and their relation to its ferroelectr properties. H. F. KAY AND P. VOUSDEN. *Phil. Mag* **40**, 1019–40 (*Oct.*, 1949).

The optical changes are described and it is shov that they can be completely explained if the cryst symmetry changes from tetragonal to orthorhombi at $-5°$C, and then to rhombohedral at $-90°$ The changes were confirmed by X-ray investigation and the conclusion is that the 3 transitions are cause by the structure becoming successively spontaneous polarized along the [100], [110] and [111] cube direc tions. The relation of polarization to cell structure discussed and it is shown that the simple Loren equation is not applicable if the Ti–O interactic energy is large. An explanation of the 3 transition is outlined. L. S. GODDARD

548.74 : 537.533.7

2077. The theory of the diffraction of electrons b small crystals. H. RAETHER. *Z. Phys.*, **126** (*Nos* 1–2 185–206 (1949) *In German.*

A theoretical discussion, based on consideration of the reciprocal lattice, of the intensity distributio in a beam of electrons diffracted by thin films an small crystals. The form of the principal and sub sidiary maxima in the diffracted beam is considered Diffraction by the molecules of a gas is discussed and the effect of the subsidiary maxima on imag formation in the electron microscope is briefly mentioned. M. R. HOPKIN

GEOPHYSICS 55

550.312

2078. On applications of a formula for the calculation of the vertical gradient of gravity. W. HOFMAN. *Geofis. Pura Appl.*, **14**, 145–62 (*April–June*, 1949) *In German.*

An expression deriving the vertical gradient of gravity from its anomalies is given, considering the whole gravitational field of the earth. Evjen's formula for a plane surface [*Geophysics*, **1**, 127 (1936)] is shown to be nearly always sufficient; his method of direct structural calculation using the vertical gradient is discussed. A. BEER

550.34

2079. On the resistance experienced by a body which moves along the plane surface of an elastic solid. H. HAYASI. *J. Phys. Soc. Japan*, **2**, 196–8 (*Nov.–Dec.*, 1947).

Continuation of the author's former investigations on the deformation of the earth's surface by a disturbance travelling with uniform velocity, and exercising uniform pressure over a circular area [*Proc. Phys. Math. Soc. Japan*, **24** and **25**, 1942–43). The resistance due to dissipation of energy is calculated. A. BEER

550.36

2080. Significance of radioactivity in geophysics thermal history of the earth. W. D. URRY. *Trans Amer. Geophys. Un.*, **30**, 171–80 (*April*, 1949).

It is concluded that the effects of the exponentia decay of the atomic heat sources within the earth have lead in its early history to a heating of the upper crust, and afterwards to a nearly linear cooling. In greater depths conditions were more complicated with simultaneous heating and cooling of differen layers. The determination of the radioactivity o ultrabasic rocks and Fe meteorites indicate that a monomineralic olivine mantle and an Fe core wil have remained essentially at the initial temps. The bearing on the hypotheses of the origin of the earth is examined. A. BEER

551.46

2081. A diffraction analysis of a photograph of the sea. N. F. BARBER. Letter in *Nature, Lond.*, **164**, 485 (*Sept.* 17, 1949).

With a point source of monochromatic light 2 m in front of a 1 m focus lens an aerial photograph of the sea has been examined by placing a transparency of the photograph in contact with the lens. The

iffraction images so obtained on panchromatic film how that there exist various wave trains of different avelengths moving in different directions. It is uggested that the treatment may be applied to ecord periodicities in a mackerel sky or in the ormation in sand dunes. A. E. M. GEDDES

551.46

2082. The principles of time series analyses applied o ocean wave data. H. R. SEIWELL. *Proc. Nat. Acad. Sci., Wash.*, **35**, 518–28 (*Sept.*, 1949).

Eight ocean wave records are analysed. Correlogram analysis gives a simpler interpretation of the data than does periodogram analysis, with its many false periods. N. L. JOHNSON

550.462

2083. The influence of meteorological factors on the diffusion of radon in the air near the ground. G. ALIVERTI AND G. LOVERA. *Ann. Geofis.*, **2**, 92–102 (*Jan.*, 1949) *In Italian.*

The effect of changes in pressure was studied in wells a few m deep: results are in agreement with existing theories. L. PINCHERLE

550.462

2084. On the exhalation of radon from the ground. G. ALIVERTI AND G. LOVERA. *Ann. Geofis.*, **2**, 137–41 (*Jan.*, 1949) *In Italian.*

It is shown that from theoretical and experimental data on the exhalation it is possible to determine the coefficient of diffusion of radium emanation in the ground. At Pavia (Italy) this coeff. was found to be $\simeq 0{\cdot}013$ cgs units. L. PINCHERLE

ATMOSPHERE . METEOROLOGY 551.5

551.508.7 : 536.531

2085. Wet bulb temperatures without a wick. K. H. JEHN. *Rev. Sci. Instrum.*, **20**, 668–73 (*Sept.*, 1949).

It is desired to determine the feasibility of measuring wet bulb temps. without a wick. The sensing element is a thermistor bead of small mass and rapid response, which, when dipped into distilled water, retains water in sufficient quantity to register a wet bulb temp. when exposed to the air. The experimental apparatus and procedures are described in detail, and the data presented. It is concluded that wickless wet bulb measurements are feasible, with an accuracy of the order of $\pm 0{\cdot}1°C$. A.

551.51

2086. The earth's upper atmosphere. D. R. BATES. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 2) 215–45 (1949).

A progress report summarizing present knowledge of the atmospheric constitution, temperature and density at various levels. Theories of the origin of the ionized layers are described, and the photochemistry of the upper atmosphere is discussed with reference to the aurora and the night-sky light. A full bibliography is given. A. HUNTER

551.510.3

2087. Equilibrium of ionization in the lower atmosphere. J. J. NOLAN AND T. BURKE. Letter in *Nature, Lond.*, **164**, 454 (*Sept.* 10, 1949).

Measurements on RaA content of atmosphere indicate that conditions favouring the accumulation of RaA also favour the accumulation of condensation nuclei. W. J. G. BEYNON

551.510.4

2088. The measurements of the variation characteristics of the density of small-ions. H. NORINDER AND R. SIKSNA. *Ark. Geofys.*, **1**, *Paper* 1, 1–32 (1949).

The operation of the Ebert counter of small ions is described and possible sources of error are discussed. An improved construction of the counter is described in which the usual fan is replaced by a vacuum cleaner. The observation huts and their equipment are described and illustrated with particular reference to the heating of the huts and its influence on the ion density to be measured. The variations of the negative and positive densities at 2 observation posts are compared and it is found that the 2 stations give comparable results at low ion densities whereas at higher densities pronounced deviations are found to occur. The results obtained are presented in series of curves of a 16-days' run of the measuring devices, readings being taken every 4 min. The effects of meteorological conditions (rain, wind, humidity) are studied in detail and individual curves show the variation of the ion density during a snow storm, rainy weather and a thunderstorm. For future investigations self-registering devices are suggested. R. H. GOLDE

551.510.535

2089. Relation of sporadic *E* reflection and meteoric ionization. V. C. PINEO. *Science*, **110**, 280–3 (*Sept.* 16, 1949).

Evidence is presented for lack of correlation between observations of meteor ionization and of sporadic *E* ionization. W. J. G. BEYNON

551.510.535 : 538.566.2 : 621.396.11

2090. The analysis of ionospheric reflections. II. A. H. DE VOOGT. *Tijdschr. Ned. Radiogenoot.*, **14**, 73–85 (*May*, 1949).

Curves are given showing the polarization, time-delay and attenuation to be expected for 6 Mc/s virtual incidence propagation under assumed ionospheric conditions. Some experimental results are also presented [see *ibid.*, **13**, 183 (*Nov.*, 1948).

W. J. G. BEYNON (R)

551.510.535 : 621.396.11

2091. The reliability of ionospheric height determinations. L. A. MANNING. *Proc. Inst. Radio Engrs*, **37**, 599–603 (*June*, 1949).

A study is made of the uncertainties existing in determinations of electron distribution on virtual height data. The effect of an assumed distribution in the valley between two layers upon the necessary upper layer form is investigated and a method for evaluating the maximum error in height determination is given. [See also Abstr. 465 (1948)]. A.

551.513

2092. The significance of dynamic instability in atmospheric motions. J. S. SAWYER. *Quart. J. Roy. Met. Soc.*, **75**, 364–74 (*Oct.*, 1949).

551.515

2093. The influence of cyclones on the ozone content of the atmosphere. V. I. ARABADJI. *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 6) 817–18 (1949) *In Russian.*

An attempt to explain the variations in the O_3 content of the atmosphere depending on the weather, by an examination of the electric field in the cyclonic cloud systems. Experiments on chemical reactions in a gaseous discharge indicate that the formation of O_3 varies with the pressure, which would confirm the observed fact that the concentration is greatest in the rear of a cyclone. INDEX AERONAUTICUS

551.521.3

2094. Sky brightness at different altitudes above sea level. E. V. PYASKOVSKAYA-FESENKOVA. *Dokl. Akad. Nauk, SSSR*, **65** (*No.* 2) 155–8 (1949) *In Russian.*

551.524.7

2095. Wind and temperature measurements up to 30 Km. F. J. SCRASE. Letter in *Nature, Lond.*, **164**, 572 (*Oct.* 1, 1949).

The results of observations obtained in 7 ascents, 5 in summer and 2 in spring, by balloons in *S* and *E* England are discussed. All show between 15 and 20 km a veer in wind direction and a min. in wind speed. Above 20 km easterly winds prevail in summer but there is evidence in support of the contention that the wind at high levels changes direction from *W* to *E* in March and back again in September. Temp. shows a positive gradient $\simeq$ 1°c/km from 18 km to 30 km, but actual temps. are lower by almost 16°c than those calculated from the effect of absorption of radiation. In 3 cases double temp. min. were found, at 12 km and 17 km, indicating a discontinuity in the tropopause. The results of 2 ascents are illustrated by a diagram.

A. E. M. GEDDES

551.578.4

2096. The detection of ice nuclei in the free atmosphere. V. J. SCHAEFER. *J. Met.*, **6**, 283–5 (*Aug.*, 1949).

To obtain a better understanding of the physical processes which permit and limit the existence of supercooled clouds several methods have been developed to detect the presence of sublimation nuclei in the air. 3 different techniques found to be useful are briefly described and results obtained given in tabular form. A. E. M. GEDDES

551.59 : 522.1

The influence of the earth's atmosphere on astronomical observations. *See Abstr.* 1385

551.594

2097. Instruments for the measurement of the visual range. R. G. BEUTTELL AND A. W. BREWER. *J. Sci. Instrum. Phys. Ind.*, **26**, 357–9 (*Nov.*, 1949).

It is often necessary to know the visual range or "visibility" at times when a direct observation of "visibility marks" is not possible. This note describes a series of instruments of small size in which the visibility is measured by measuring directly the scattering coeff. of a relatively small volume of the air. The instruments take different forms according to what is most convenient for the conditions of use but all give the true scattering coeff. irrespective (within wide limits) of the nature of the polar distribution of the scattered light. This is achieved because the polar curve is effectively integrated in the measurement. A

551.594

2098. Incidence of light from high altitudes. J. HOUTGAST. *Ned. T. Natuurkde*, **15**, 181–92 (*Aug.* 1949) *In Dutch.*

A brief discussion is given of the problems concerning the incidence of light from the upper atmosphere and of its probable origins. Local fluctuations in intensity (polar light) are usually ascribed to the penetration of fast particles of solar origin, and the constant background to the sun's radiation from the far ultraviolet. This radiation dissociates and ionizes the upper layers of the atmosphere by day, and the night emission is caused by subsequent release of potential energy due to recombination. The spectrum of the aurora is compared with that of the background and polar radiation. E. P. WOHLFARTH

551.594.33

2099. Auroral radiation in the 3 000-megacycle region. P. A. FORSYTH, W. PETRIE AND B. W. CURRIE. Letter in *Nature, Lond.*, **164**, 453 (*Sept.* 10, 1949).

Pulses of radiation of duration 1–5 μsec, arriving in a random manner in bursts of short duration ($\ll$ 1 sec) were observed visually on the indicator of a radar set with transmitter off. Auroral origin was confirmed by observations of 20 aurorae, the part of the display to which the receiving aerial pointed at any time being photographed. Some correlation between frequency of pulses and intensity and type of aurora was found. M. W. OVENDEN

BIOLOGY 57/59

578.088

2100. Biological effects of roentgen rays of various wavelengths. V. V. BRUNST AND E. A. SHEREMETIEVA-BRUNST. *Amer. J. Roentgenol. Radium Ther.*, **62**, 252–6 (*Aug.*, 1949).

A comparison of effects of X-rays of 43 and 140 kV on the tails of tritons is given. Regeneration of the tissue after amputation through the irradiated region, as well as necrosis, showed no significant difference between the two qualities of radiation.

F. T. FARMER

MEDICAL SCIENCE
HUMAN PHYSIOLOGY 61

612.84

2101. The coefficient of specific resolution of the human eye for Foucault test objects viewed through circular apertures. H. S. COLEMAN, M. F. COLEMAN, D. L. FRIDGE AND S. W. HARDING. *J. Opt. Soc. Amer.*, **39**, 766–70 (*Sept.*, 1949).

612.84

02. The photochemical theories of vision as based l classical and quantum concepts and the nervous hibition at visual thresholds. E. BAUMGARDT. ev. Opt. (*Théor. Instrum.*) **28,** 453–78 (*Aug.–Sept.*, 949) *In French.*

It is shown that Hecht's first hypothesis is untenable id the second superfluous. Adaptation phenomena e said to be principally due to a nervous mechanism. he threshold of vision is dealt with by a method Abstr. 196 (1945)] previously used, and 4–10 photons re calculated to be required for a light stimulus to licit a visual sensation. It is shown that there is no ontradiction between this and the author's view hat 2 quanta are sufficient, provided the interval etween their absorption by the same element does ot exceed a definite period τ. Only 2 quanta satisfy he theoretical requirements. τ depends on the etinal point and area of stimulation, and the wave-ength. Ricco's law is said to be valid within an area overed by a ganglionic cell. The quantitative reatment is accompanied by numerous graphs. It s shown qualitatively that the foveal threshold nergies must be $\gg$ than the extrafoveal.

R. A. WEALE

612.84

2103. Change in absorption spectrum of visual purple with temperature. R. A. WEALE. *Helv. Phys. Acta*, **22** (*No.* 2) 164–6 (1949) *In German.*

A criticism of a paper by Herczog and Wieland [Abstr. 4651 (1949)]. C. B. ALLSOPP

612.84

2104. Absorption spectra, molecular weights, and visual purple. F. D. COLLINS AND R. A. MORTON. Letter in *Nature, Lond.*, **164,** 528–9 (*Sept.* 24, 1949).

The recent calculations [Abstr. 5827 (1949)] of the molecular weights of haemoglobin and visual purple, based on Houston's expression [*Proc. Roy. Soc. A*, **82,** 606 (1909)], are criticized because of the discrepancy between this and modern formulae. An expression for the max. carrier weight of the visual purple molecule is derived from experiments performed in the authors' laboratory, and the number of chromophores per molecule given as 2 or 3. Hecht and Pickels [*Proc. Nat. Acad. Sci., Wash.*, **24,** 172 (1938)] value of the molecular weight is taken as basis. A table with spectroscopic data for vitamin A and related compounds is added. R. A. WEALE

612.84

2105. Variations of the spectral sensitivity of the eye under great intensities. S. G. YUROV. *Dokl. Akad. Nauk, SSSR,* **67** (*No.* 2) 271–3 (1949) *In Russian.*

These were compared using Pulfrich's and other photometers. For brightness of 6–250 dcmsb spectral sensitivity is not a simple function of the wavelength of the radiation falling upon the eye but depends also upon its spectral composition; previous adaptation and the state of the observer, also distribution of radiation on retina, have some influence. These changes of sensitivity may lead to errors in photometry, unimportant however in filter method. The results can only be explained by a far more complex sight process, not on the theory of only two light-sensitive mechanisms. J. JACOBS

612.84 : 535.7

On the optical properties of the crystalline lens. *See Abstr.* 1695

614.8

2106. Bibliography on radiation protection. H. H. GOLDSMITH. *Nucleonics*, **4,** 62–9 (*June*, 1949).

References are grouped under the following heads: general biological effects of radiation; blood changes due to radiation; radiation sickness; atomic bomb effects; tolerance doses and dosage measurements; radiation exposure monitoring; health protection measures; dust monitoring and hazards; laboratory designs. A. P. FRENCH

614.8 : 537.533.72 : 537.531

X-ray output of electron microscope: personal hazard. *See Abstr.* 1781

614.8 : 539.172.4

Shielding from nuclear radiation. *See Abstr.* 2007

615.849 : 621.317.723 : 537.542

A dynamic electrometer for small condenser chambers. *See Abstr.* 1813

616-073.75

2107. The quantitative evaluation of bone density. P. B. MACK, W. N. BROWN AND H. D. TRAPP. *Amer. J. Roentgenol. Radium Ther.*, **61,** 808–25 (*June*, 1949).

Using a step-wedge of ivory to simulate bone composition the relative blackening of wedge and bone shadows is determined by a recording microphotometer and the average calcium density over a cross-section of bone is derived. Soft tissue absorption and scattering are neglected. By means of a function transformer set from the wedge readings, automatic recording of equivalent ivory thickness for any region of bone selected on the film is obtained. F. T. FARMER

PHOTOGRAPHY 77

771.53

2108. Minimum and maximum sensitivities of photographic emulsions. A. P. H. TRIVELLI. *J. Franklin Inst.*, **248,** 225–30 (*Sept.*, 1949).

It was found empirically that in emulsion coatings producing characteristic curves representable by single term quantic equations, there is a straight line relation between ε/r and $10/i$, where ε is the probability of a grain of unit projective area becoming developable, r the min. number of absorbed quanta required to render a grain developable, i the inertia point of the D/log. E curve and $10/i$ the inertia speed of photographic emulsions. The straight line relation shows a definite min. value of $\varepsilon/r = 6 \cdot 10^{-5}$ for AgBr and of $\varepsilon/r = 4 \cdot 10^{-5}$ for Ag bromoiodide emulsions. The min. size of the effective surface of

the Ag bromoiodide grains of a commercial emulsion was calculated to be of the order of 100–200 atoms.

R. H. HERZ

771.53

2109. The measurement of the thickness of silver halide crystals of photographic emulsion by means of the Linnik micro-interferometer with 90 power objectives. P. V. MEIKLYAR AND P. KH. PRUSS. *J. Tech. Phys., USSR.*, **19**, 1032–40 (*Sept.*, 1949) *In Russian.*

771.534.1 : 545.82

2110. On the variability of photographic measurement of relative intensity of photographic lines. M. HONERJÄGER-SÖHM AND H. KAISER. *Acta Spectrochim*, **3** (*Nos* 5–6) 498–517 (1949) *In German.*

In routine analysis it was found that the density differences for a pair of lines of constant relative intensity were different on different plates, and that the variability of this difference is related to the geometrical distance between the line images. The variability on a single plate is much less affected by the distance between the lines. The cause of this variation is traced to non-uniformity of development and partly to non-uniformity of emulsion coatings. The consequences of this for routine spectrographic analysis with permanent calibration curves are discussed, and mechanized development techniques are recommended. A.

771.534.5

2111. A photoelectric microdensitometer. M. A. LESSLER AND H. A. CHARIPPER. *Science*, **110**, 429–30 (*Oct.* 21, 1949).

A simple form of the above is described, and a photograph and drawing of the instrument shown. It is suitable for the "semi-quantitative" determination of colorimetric histo- and cytochemical tests, and can be adapted to microchemical work. R. A. WEALE

771.534.531.5

2112. A logarithmic potentiometer for photographic densitometry. J. A. HALL. *J. Sci. Instrum. Phys. Ind.*, **26**, 365–6 (*Nov.*, 1949).

A logarithmic potentiometer directly reading in density has been designed for use with a microphotometer employing a barrier-layer photocell as detector. The potentiometer incorporates a Campbell–Freeth circuit and is accurate to within $\pm 0{\cdot}002$ in density. A.

778.3

2113. Shrinkage of photographic emulsions for nuclear research. J. ROTBLAT AND C. T. TAI. Letter in *Nature, Lond.*, **164**, 835–6 (*Nov.* 12, 1949).

The high ratio of Ag halide to gelatin in nuclear track emulsions causes a considerable shrinkage of the emulsion at processing due to the removal of the unexposed Ag halides in the fixing process. For the correct interpretation of nuclear events an accurate knowledge of the orientation of the path of the particle and its track in the emulsion is required. The correction for shrinkage is usually done by multiplying the vertical projection of the track length by the shrinkage factor (S), i.e. the ratio of the thickness of the emulsion at exposure to that after processing and drying. This ratio has been measured and found to be $2{\cdot}7 \pm 0{\cdot}2$ for Ilford *C2*, *E1*, *G5* and Kodak *NT1a*, *NT2a* and *NT* emulsions. For Li loaded emulsions S may reach 3·2. The shrinkage factor has been found to be fairly uniform throughout the depth of a 200 μ Li loaded emulsion by measuring the angular distribution of $H^3 + \alpha$ tracks from the disintegration of Li by thermal neutron bombardment. The effect on large angles of dip was also studied by measurements of the horizontal and vertical components of each track. R. H. HERZ

778.3 : 537.133

2114. The photographic effect of protons of medium velocity. P. BRIX. *Z. Phys.*, **126** (*No* 1–2) 35–42 (1949) *In German.*

Density-log. exposure curves taken from proton exposures on Agfa Autolith plates show a distinct hump. The energies of the protons used cover a range of 2·6–7·0 keV. The hump is explained by the assumption of a superimposition of two processes: (*a*) Direct AgBr-grain hits by protons, reaching saturation when all grains within the range of the protons are rendered developable. (*b*) The grains situated beyond the range distance of protons are rendered developable by secondary radiation which is believed to be of electromagnetic character. From analysis of the two processes, it is concluded that the grain yield per incident proton ~ 1. In the secondary process 10^5 protons are required to render one grain developable. R. H. HERZ

778.33

2115. Photoelectric exposure meter for industrial radiography. D. T. R. DIGHTON AND R. H. HERZ. *J. Sci. Instrum. Phys. Ind.*, **26**, 404–7 (*Dec.*, 1949).

An exposure meter for industrial radiography, using a multiplier photocell in conjunction with 2 different types of fluorescent screens, is described. The meter can be used for intensifying-screen and non-screen exposures and covers a range of X-rays generated between 40 and 200 kVp. A.

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